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Assessing moral reasoning and career decision-making among intellectually precocious youth

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Assessing moral reasoning and career decision-making among intellectually precocious youth

by

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GENERAL INTRODUCTION

Individuals in our society who exhibit advanced functioning have not always been highly regarded, but hindsight has made it clear that extremely creative, talented and intellectually gifted people have the potential to exert a substantial influence on our world. According to Benbow (1988) and Blumenthal (1987), highly gifted individuals form the pool from which our future leaders emerge. Since our future is closely linked to the decisions, inventions, theories, discoveries, actions, and rationales provided by these individuals (Lewis, 1982; Passow, 1988), investigations concerning the moral development, as well as the career decision-making processes of intellectually precocious youth, would seem valuable. Both of these issues will be addressed in this dissertation.

A number of studies have been conducted on the psychosocial development of intellectually precocious individuals and have generally concluded that gifted youth show advancement when compared with peers of average ability (Abroms & Gollin, 1980; Brody & Benbow, 1986; Derevensky & Coleman, 1989). These conclusions are based on various social-emotional developmental assessments including measures of moral reasoning. Since information concerning the moral reasoning of gifted individuals has potential importance for societal well-being, it seems beneficial to investigate what current tests of moral reasoning truly measure. Are they reflective of social maturity or, as some have suggested, reflective of higher general intellectual functioning? Hence, the moral reasoning of gifted youth, as well as possible correlates of advanced moral reasoning, were investigated. Section I of the dissertation describes this research.

Career choices made by intellectually precocious youth also are of great importance to our society. Where do they decide to focus their talents, and why? One of this nation's major concerns today involves the projected shortage of scientists and engineers, particularly females (Tobias, 1990). Because the mathematically gifted population has the highest potential for success in these fields (Green, 1989; Walberg, 1983) and they enter science in disproportionately high numbers (Benbow & Arjmand, 1990), the research presented in Section II was conducted to empirically identify characteristics of mathematically talented females who pursue college majors and careers in mathematics and science and those who do not. In addition, individuals making changes in educational aspirations over the college years were examined. To assess possible gender differences in career decision-making, mathematically precocious males were investigated.

Explanation of Dissertation Format

The alternate format was used for this dissertation. The dissertation consists of two papers prepared for publication. Following the research studies is a General Summary and Discussion section. All literature cited in the General Introduction and General Summary and Discussion sections can be found after the General Summary and Discussion section.

SECTION I: ASSESSING THE DISTINCTIVENESS OF MORAL REASONING MEASURES AMONG INTELLECTUALLY GIFTED ADOLESCENTS

ABSTRACT

Moral reasoning was examined among 523 highly gifted youth. Two studies were conducted, with Study 2 serving as a replication of Study 1. Results obtained from the Defining Issues Test (DIT), a test purporting to measure moral reasoning, revealed that gifted individuals earned significantly higher moral reasoning scores than did their average ability peers; they also scored higher than college freshmen, who were 4 to 5 years older. Also examined among the highly gifted were possible correlates of principled moral reasoning: ability (SAT-M, SAT-V, and Raven scores), personality characteristics, values, family environmental characteristics, family socioeconomic status, and extracurricular involvement. In general, measures of intelligence were the only variables significantly correlated with principled moral reasoning. The hypothesis that the DIT is conceptually distinct from conventional measures of general intelligence was evaluated with negative results. Investigators conducting subsequent studies involving the assessment of moral reasoning, however measured, are advised to incorporate conventional measures of general intelligence into their designs.

INTRODUCTION

The subject of moral reasoning is currently being treated as a critical topic in the field of psychology (Diessner, 1991). This is understandable with increases in such societal problems as suicides, homicides, unwanted teen pregnancies, and use of recreational drugs (Vitz, 1990). In this regard, the moral reasoning of intellectually precocious youth is of special interest because these individuals form the pool from which our future leaders emerge (Benbow, 1988; Blumenthal, 1987); thus, they have the potential to exert a substantial influence on our world and may be the individuals addressing these problems in the future. The numerous studies conducted on the psychosocial development of intellectually precocious individuals generally conclude that gifted youth are superior when compared to their average ability peers (Abroms & Gollin, 1980; Brody & Benbow, 1986; Derevensky & Coleman, 1989; Janos & Robinson, 1985; Robinson & Noble, 1991). These conclusions regarding social maturity are based on various social-emotional developmental assessments but to a large extent on results using measures of moral reasoning. It is not known, however, what their advanced moral reasoning scores truly reflect. Hence, this study was designed to investigate the moral reasoning of gifted youth and its possible correlates.

For background purposes, a brief review of Kohlberg's theory of moral development and related literature on moral reasoning is provided. Second, research literature on the relationship between moral reasoning and each of the following areas studied in this research is delineated in order to provide a rationale for their association with moral reasoning: intelligence, personality, values, family characteristics, gender, and extracurricular activities. Frequently, these variables are viewed as correlates and causes of level of moral reasoning. This investigation evaluated the nature and strength of their relationship with objective assessments of moral reasoning among the gifted.

Kohlberg's Theory of Moral Development

Using Piaget's (1932) theory of moral judgment for children, Lawrence Kohlberg (1958) developed a comprehensive stage theory of moral development that can be empirically evaluated. Kohlberg describes three levels of moral development, with each level subdivided into two distinct stages. The stages are arranged sequentially in successive tiers of complexity. According to Kohlberg, every individual progresses through the same series beginning with avoidance of punishment (stage 1) to a system of judgment based on ethical personal values of justice and respect for the dignity of the individual (stage 6) (Kohlberg, 1971).

The numerous studies investigating moral reasoning based on Kohlberg's theory have confirmed basic tenets regarding the topic area. Cross-sectional data have shown that older subjects tend to use higher stages of moral reasoning when compared to younger participants (Kohlberg, 1969; Rest, 1979a), while longitudinal studies report "upward" progression, in accordance with Kohlberg's theoretical order of the stages (Holstein, 1976; Kramer, 1968; Kuhn, 1976; Kohlberg, 1978; Sanders, in preparation). In addition, comprehension studies have revealed that comprehension of the stages is cumulative (for instance, if a person understands Stage 3, he/she understands the lower stages but not necessarily the higher stages), and comprehension of higher stages is increasingly difficult (Rest, Turiel, & Kohlberg, 1969; Rest, 1973). Moreover, age trends in moral development have received cross-cultural support (Edwards, 1978; Gorsuch & Barnes, 1973; Parikh, 1980; Snarey, Reimer & Kohlberg, 1984).

Since the development of Kohlberg's moral reasoning theory, a number of instruments that purport to measure moral reasoning have been constructed. The Moral Judgement Interview (MJI) (Kohlberg, 1969) is a rather lengthy structured interview requiring trained interviewers and scorers. Other instruments include the Defining Issues Test (DIT) (Rest, 1979b), an objective form of the MJI (Maitland & Goldman, 1974), and the Measure of Conscience (Hoffman, 1970). These measures, ranging from projective tests to structured, objective assessments, all consist of a set of hypothetical stories involving moral dilemmas.

Six Classes of Correlates of Moral Reasoning

Intelligence. A number of studies support the claim that intelligence is related to moral reasoning (Abel, 1941; Caring, 1972; Durkin, 1959; Janos & Robinson, 1985; Kohlberg, 1969; Whiteman & Klosier, 1964). Kohlberg (1969) reported correlations of the MJI to intelligence tests ranging from .30 to .50, while Rest (1979a) indicates that correlations between the DIT and intelligence fall in the range of .20 to .50. After equating for mental age, the moral reasoning abilities of kindergarten and first grade children (Perry & Krebs, 1980), as well as retarded adolescents and younger children (Boehm, 1967), were comparable. Moreover, Caring (1972) demonstrated that IQ was the best predictor of moral maturity among 10 to 12 year olds with IQ's ranging from 88 to 144. Although there is support that moral reasoning is correlated with verbal ability (Karnes & Brown, 1981), a number of studies reported by Rest (1979a) suggest that math and science test scores seem to predict DIT scores as well as language, vocabulary, or social science test scores. Thus, high scores on the DIT do not appear to be due to particular abilities, such as reading or vocabulary skills, but rather to more general cognitive development or general intelligence.

Although empirical studies involving gifted individuals are few (Blumenthal, 1987; Broad, 1972), the available data suggest that gifted individuals exhibit advanced moral reasoning. Not only is there evidence of advanced moral reasoning of gifted children (Simmons & Zumpf, 1986; Terman, 1925), but also for gifted adolescents (Janos, Robinson, & Sather, 1983; Tan-Willman & Gutteridge, 1981). Simmons and Zumpf (1986) claimed that gifted individuals move through Kohlberg's stages of moral development more quickly than do their average ability peers. Because these individuals apparently exhibit advanced moral reasoning, the relationship between intelligence and moral reasoning was of paramount interest in this study.

Personality Characteristics. Other studies have investigated the relationship between personality characteristics and moral reasoning (Cauble, 1976; Hanson & Mullis, 1985; Jacobs, 1975; Johnson, 1974; Masanz, 1975). Characteristics, such as "Achievement via independence" and "Intellectual efficiency," were found to have correlations of .48 and .42, respectively, with DIT scores (Hartwick, 1975, cited in Rest, 1979a). Schomberg (1975) reported significant positive correlations with "Complexity," "Autonomy," and a negative correlation with "Practical outlook." Thus, it seems that the aspects of personality associated with cognitive development might be the most powerful personality correlates of moral reasoning.

Values. A number of studies have investigated the relationship between moral reasoning and values and report few significant correlations. Using the Study of Values with high school students (Schneeweis, 1974) and graduate students (Constantian & McAdams, 1977), no significant relationship between values and moral reasoning were found. In addition, few significant correlations between moral reasoning and values derived from Rokeach's Value Survey (1973) have been reported (Lockley, 1976; Standring, 1976, cited in Rest, 1979a).

Family Characteristics. Mixed results have been reported on the relationship between socioeconomic status (SES) and moral reasoning. Results from studies using the Hollingshead's two factor index of SES (an aggregate of parents' educational levels) revealed correlations ranging from .35 to .38 between moral reasoning and SES (Cauble, 1975, 1976). Other studies assessing SES by parental occupations, however, indicated a correlational range of .11 to .19 (McColgan, 1975; Rest, Cooper, Coder, Masanz, & Anderson, 1974). Thus, education may be the critical component of SES that is related to moral reasoning.

Gender. A current concern of "gender-bias" in the Kohlbergian assessment of moral reasoning has drawn much attention to the issue of gender differences in moral development (Bussey & Maughan, 1982; Gilligan, 1982a). A number of studies provide little support for moral reasoning as a gender-differentiating attribute (Rest, 1975, 1979a; Walker, 1984). Walker (1984) claimed that gender accounts for approximately .0005% of the variance in moral reasoning. Nonetheless, other research has revealed that women exhibit an overall pattern of lower stage preference as compared to males (Baumrind, 1986; Pratt, Golding, & Hunter, 1983). Some of these differences, however, were found only when education was not controlled.

Extracurricular Activities. According to Kohlberg (1978) and Rest (1976), involvement in extracurricular activities that allow for role-taking, group interaction, and leadership opportunities should be positively related to moral reasoning. But, results in this area have been mixed. Biggs and Barnett (1981) reported a negative correlation between moral reasoning and high school extracurricular involvement for college seniors who received high moral reasoning scores as freshmen, while Duffy (1982) revealed that students with volunteer experience showed significantly higher rates of moral growth than those without the experience. Moreover, Laubscher (1988) concluded that involvement in extracurricular activities at the high school level positively influenced adults' moral development. These inconsistent findings display the need to assess the quality of experiences students are exposed to in extracurricular activities and its relationship with moral reasoning

Conclusions

With the exception of education and intelligence, research conducted on the general population reveals that, in general, most variables (e.g., values, personality characteristics) are not related to moral development and, if they are, only weakly. Even those that do correlate often tend to be aspects of or related to cognitive development. Yet, few studies have investigated the incremental validity of nonintellectual attributes (beyond intellectual functioning). Therefore, an hypothesis that emerges is that tests purporting to measure moral reasoning share appreciable communality with conventional measures of intelligence. Thus, the discriminant validity of the DIT (i.e., its ability to produce unique information not accounted for by other variables) was investigated. In addition, given the above discussion, the incremental validity of correlates of moral reasoning beyond intelligence was given particular attention.

The few studies assessing the moral reasoning of gifted students suggest that gifted youth exhibit advanced levels of moral reasoning in contrast to their average ability peers. This finding hints again toward an association between moral reasoning and general intellectual functioning; it is not clear whether higher scores on moral reasoning measures reflect social maturity or higher general intelligence. Therefore, this study was conducted to address the aforementioned issue, with the attempt to tease apart the general intelligence/moral reasoning relationship.

Two studies were included in this research for purposes of replication. Study 1 focused on gifted youth who attended the Challenges for Youth - Talented and Gifted (CY-TAG) and Iowa Governor's Institute programs at Iowa State University during the summer of 1990. Utilizing attenders from the summer of 1991, Study 2 served as a replication of Study 1.

METHOD

Subjects

The participants selected for Study 1 were 147 male and 121 female students who attended the CY-TAG and Governor's Institute programs in the summer of 1990 and for Study 2 136 male and 119 female students who attended the programs during the summer of 1991. Since not all subjects had taken the SAT, sample sizes for the analyses involving SAT scores were as follows: 92 males and 72 females for Study 1, 102 males and 83 females for Study 2. Demographic characteristics of the participants are summarized in Appendix A.

Individuals are eligible for CY-TAG and Iowa Governor's Institute programs if they are currently enrolled in 7th to 10th grade[1]. Additional requirements for CY-TAG involve earning one of the following test scores as a 7th-grader: $\geq$ 500 on the SAT-Math subtest, $\geq$ 430 on the SAT-Verbal subtest, or $\geq$ 20 on any ACT subtest. Minimum SAT and ACT scores earned by CY-TAG participants at age 12 to 13 are comparable to the average score received by college-bound high school senior males. Although selection for the Governor's Institute program is not based on SAT or ACT scores, many such students had taken these tests. Those who did earn scores comparable to CY-TAG participants were included in the present research. Thus, the sample represents approximately the top 1/2% in intellectual ability as measured by the SAT or ACT.

Two control groups also were used. A control group of equivalent chronological age to the gifted youth consisted of 30 male and 27 female 12-to-14 year olds of average ability[2,3]. These subjects were paid $5.00 for their participation. The second control group, consisting of 131 male and female college freshmen, served as a control group of equivalent mental age to the gifted youth. They received extra credit in an Introductory Psychology class for their participation.

Instrumentation

Materials used were selected items and scales from the following instruments: "Defining Issues Test" (Rest, 1979b); "Family Environment Scale" (Moos & Moos, 1986), "Adjective Checklist" (Gough & Heilbrun, 1983); "Study of Values - Revised" (Allport, Vernon, & Lindzey, 1970); "Raven's Progressive Matrices" (Raven, Court & Raven, 1977); "Background Questionnaire for CY-TAG Students"; and"Activities Questionnaire". Descriptions of the variables used from each instrument are provided next.

Defining Issues Test. Moral reasoning was assessed by the DIT, a standardized instrument based on Kohlberg's theory of moral development constructed by Rest (1979b). It is an objective instrument consisting of six story dilemmas, each describing a situation requiring an ethical decision. Associated with each dilemma are 12 statements representing a particular stage of moral judgment. The participants are asked to rate the importance of each statement and to select the four most important issues ranking them in order of importance. Scores are based on the relative importance participants place on stage-related statements. The following breakdown describes the various outcome scores provided by the DIT (Rest, 1979b) that were used in both studies:

DIT Outcome Scores

Outcome	Description
Stage scores	The amount of reasoning displayed by subjects at stages 2, 3, 4, 5a, 5b, and 6.
P-score	The amount of Principled reasoning, expressed as the sum of stages 5a, 5b, and 6.
P%	The P score divided by the maximum P of 60.
M-score	The amount of importance attached to meaningless statements.
Consistency Check	A comparison of ratings and rankings of statements.

Family Environment Scale. The social-environmental characteristics of family were assessed by the "Family Environment Scale" (FES; Moos & Moos, 1986). The FES consists of ten scales that are classified into three underlying domains: relationships, personal growth, and system maintenance. The Relationship dimension is made up of the Cohesion, Expressiveness, and Conflict subscales. This dimension assesses the extent to which family members are supportive, open, and expressive with each other. The Personal Growth dimension is measured by the Independence, Achievement Orientation, Intellectual-Cultural Orientation, Active-Recreational Orientation, and Moral-Religious Emphasis subscales. This dimension focuses on the degree to which family members are assertive, self-sufficient, and interested in political, social, intellectual, religious, cultural, and recreational activities. The System Maintenance dimension is assessed by the Organization and Control subscales. This dimension involves how important structure and organization are in the family unit.

There are three forms of the FES, the Real, Ideal, and Expectations form. The Real form was used in this research. It measures the students' perceptions of their family environment.

Adjective Checklist. The "Adjective Checklist" (ACL; Gough & Heilbrun, 1983) was used to assess personality attributes. The ACL is comprised of 37 scales categorized into five classes. The first class, measuring needs, consists of achievement, dominance, endurance, order, intraception, nurturance, affiliations, heterosexuality, exhibition, autonomy, aggression, change, succorance, abasement, and deference. Topical scales include: counseling readiness, self-control, self-confidence, personal adjustment, ideal self, creative personality, military leadership, masculine attributes, and feminine attributes. Transactional analysis scales, based on Berne's (1961) primary ego states, consist of: critical parent, nurturing parent, adult, free child, and adapted child scales. Lastly, the Origence-Intellectence scales, assessing one's ability to reason abstractly as well as creatively, include high origence, low intellectence; high origence, high intellectence; low origence, low intellectence; and low origence, high intellectence. The Modus Operandi scale was not used. Participants are given a list of 300 adjectives and asked to circle the ones they feel are self-descriptive. Scores are based on which adjectives are chosen.

Study of Values. The "Study of Values" (SOV; Allport, Vernon, & Lindzey, 1970) was used to assess the relative preference for six basic aspects of personality in an ipsative fashion. The six interests include theoretical, economic, aesthetic, social, political, and religious areas. The SOV is based on the view that people's personalities are best assessed by investigating their value systems. Although the SOV is a self-administered test designed primarily for college students or adults who have had some college or equivalent education, use of the instrument with participants of this research was acceptable due to their high ability and the long tradition of using this instrument with such students (c.f. Keating, 1974).

The SOV consists of 120 items; 20 items relate to each of the six aforementioned values. Each question is based on a common situation, and alternative answers are provided.

Raven's Advanced Progressive Matrices and Vocabulary Scales (APM; Raven, Court, & Raven, 1977). The Ravens was used as a test of non-verbal reasoning ability. It is a "culture-fair" assessment consisting of 36 items. Each item involves a meaningless figure and a relational problem to be solved. A number of alternative answers are provided for each question.

Background Questionnaire for CY-TAG Students. The "Background Questionnaire for CY-TAG Students" is a general information survey completed by all participants of CY-TAG and Iowa Governor's Institute programs. Demographic information, as well as questions pertaining to students' feelings and opinions, are included in the questionnaire. The following four items were used from this questionnaire as indices of SES: paternal educational level, maternal educational level, paternal occupation, and maternal occupation.[4]

Activities Questionnaire. The "Activities Questionnaire" was used to assess extent of participation in various activities and hobbies. Using data collected in 1990, a factor analysis was conducted to empirically reduce the number of variables involved in this assessment. Varimax rotation was used to generate orthogonal factors (see factor analytic results in Appendix B; squared multiple correlations reported in the diagonal). The analysis yielded nine factors with eigenvalues greater than 1.0. Scree test results revealed four factors accounting for the majority of the variance, but five psychologically meaningful factors. Thus, for purposes of this research, the first five factors were used since they involved activities that may relate to moral reasoning and cognitive development. The factors reflected involvement in non-fiction reading, school clubs, math/science related activities, video games, and fiction reading. The amount of participation in extracurricular activities was represented by the number of activities in which subjects reported participation.

Data Collection. The majority of the questionnaires were mailed to all participants prior to the beginning of their program session or administered to the students during the first full day of the program.

Response Rates

The response rate for the participants varied for each questionnaire. The mean percent response rate was 94%.

Statistical Analyses. Analyses were computed using the SPSSX computer program. Data were analyzed using t-tests, ANOVA's, Pearson product-moment correlation coefficients, and multiple regression analyses. A difference was considered statistically significant if $p < .05$. Effect sizes (for means: $d = [X_1 - X_2]/SD$; average SD was used) (Cohen, 1977) were calculated. Cohen (1988) arbitrarily classified correlations as small effects if $.1 \leq r < .3$, medium if $.3 \leq r < .5$, and large if $r \geq .5$. Effect sizes for means are considered small when they are $.2 \leq d < .5$, medium ($.5 \leq d < .8$), and large ($d \geq .8$). Cohen (1988) describes a medium effect size as the "degree of relationship [that] would be perceptible to the naked eye of a reasonably sensitive observer" (p. 80) and places a large effect size in the category of "about as high as they come" (p. 81). Medium and large effect sizes were considered important in this research. In addition, only those statistically significant findings that were replicated were considered useful. For analyses involving possible correlates of moral reasoning, SAT scores were age-adjusted so that they were congruent with the time that all other assessments were completed (e.g., a 1991 participant who earned SAT scores in 1990 would have his/her SAT scores adjusted to his/her 1991 age).

RESULTS

All possible coefficient alpha's were computed for the many dependent measures and are given in Table 1. In addition, test-retest reliabilities were computed based on a subset of individuals who attended the gifted programs two consecutive years (N=78) and also are provided in Table 1. It should be noted that test-retest reliability coefficients for some of the ACL scales were relatively low (see Table 1), indicating that utility of this measure for longitudinal studies involving individuals similar to the present sample is questionable. Nonetheless, due to the popularity and history of this instrument, the results obtained from the ACL were reported.

Moral reasoning of gifted youth

Means and standard deviations for moral reasoning stage scores earned by the gifted youth are included in Table 2. Both samples were functioning predominantly at stage 4. No significant sex differences in stage scores were replicated.

Table 3 summarizes the means and standard deviations for P%-scores earned by gifted youth, average ability 7th and 8th graders, and college freshmen[5]. A 3(groups) x 2(sex) ANOVA revealed significant differences between groups, $F(2,455) = 25.7$, $p < .001$. Results from Scheffe's test for unplanned comparisons revealed that the gifted group earned significantly higher P-scores than did the average ability group ($p < .001$; $d = 1.1$) and college freshmen ($p < .005$; $d = .36$). Sex and sex X group interaction terms were not statistically significant. When comparing the gifted group to standardized norms for junior and senior high school students derived from the DIT (see Table 3) (Rest, 1975), the gifted individuals scored significantly higher than junior high, $t = 15.8$, $p < .001$; $d = 1.2$, and senior high school students, $t = 3.2$, $p < .001$; $d = .23$.

Moral development of gifted youth

Changes in P%-scores for those gifted individuals who attended CY-TAG and Governor's Institute Programs two consecutive years (1990 and 1991) are summarized in Figure 1. Results from a repeated measures ANOVA revealed that gifted youth's P%-scores significantly increased over a one-year time period, $F(1,76) = 19.6$, $p < .001$, $d = .46$. No significant sex difference nor sex X time interaction were found.

Table 4 includes means and standard deviations for P-scores earned by 6th through 10th grade gifted individuals. Utilizing this cross-sectional data[6], significant differences in P-scores earned at various grade levels were revealed, $F(2,246) = 5.3$, $p < .01$, providing support for the "upward" developmental progression of moral reasoning claimed by Kohlberg.

Correlates of principled moral reasoning measure

Pearson correlation coefficients between principled moral reasoning and all aforementioned variables were computed. In addition to being calculated for the entire group, correlations also were calculated for males and females separately (see Appendix C). Since the relationship between moral reasoning and a large number of variables were investigated, the probability of committing a Type I error was quite high. Thus, only those correlations that were significant in both Study 1 and Study 2 were considered for more detailed analysis. These replicated correlations are given in Table 5.

The replicated results revealed that all ability measures were significantly correlated with principled moral reasoning (their median $r = .27$). Taking into account the restricted range in ability of the sample, these correlations were impressive. Only five of the 59 other variables investigated had significant relationships with principled moral reasoning (for the five variables: median $r = .17$). That is, only 8% of the non-cognitive variables studied were significantly related to principled moral reasoning, while 100% of the cognitive variables manifested a significant relationship.

In order to assess the incremental validity of the non-cognitive factors significantly correlated with principled moral reasoning, forward stepwise multiple regression analyses were conducted, using principled moral reasoning as the criterion variable. Three analyses were computed for each non-cognitive correlate, placing them in competition with SAT-V, SAT-M, and Raven scores individually. Results revealed that extracurricular activity involving video games was the only non-cognitive correlate with any incremental validity beyond the cognitive variables. Video game activity displayed 5% (Study 1), 6% (Study 2) incremental validity following SAT-M scores and 5% (Study 1), 3% (Study 2) incremental validity following Raven scores. No incremental validity, however, was evident when including SAT-V scores in the analysis. Video game playing was negatively correlated with moral reasoning.

The correlations between the cognitive variables, as well as their correlations with principled moral reasoning are provided in Table 6. Correlations for females are given in the top half of the diagonal, while correlations for males are provided in the bottom half. Test-retest reliability estimates for a subset of the entire sample are given in the diagonal entries placed in brackets. The variables assessing general intelligence were correlated as strongly with principled moral reasoning as they were with each other (r's ranging from .15 to .56). These correlations are high considering that the sample studied was highly restricted in ability.

DISCUSSION

The purpose of the study was to assess the moral reasoning of gifted youth and its possible correlates. Since past research has shown that, in general, variables that relate to moral reasoning tend to be cognitive in nature, this research attempted to evaluate the hypothesis that the DIT, a test purporting to measure moral reasoning, is conceptually equivalent to conventional measures of general intelligence. Thus, the discriminant validity of the DIT was assessed.

On the one hand, findings from this study lend support for the basic tenets of Kohlberg's theory of moral development. That is, the cross-sectional data suggest that older subjects use higher stages of moral reasoning than do younger subjects. In addition, the longitudinal data reveal that individuals experience an "upward" progression of moral development, in accordance with Kohlberg's theoretical order of the moral reasoning stages. Gender differences are not apparent. Further, in terms of the gifted population, this sample of intellectually precocious youth exhibited advanced levels of "moral reasoning", even exceeding levels demonstrated by college freshmen. Does this mean that the gifted demonstrate a special kind of social maturity?

Multiple discriminant validation analyses of the DIT, in relation to measures of general intelligence, cast doubt upon the aforementioned interpretation of the scores obtained from the DIT. After investigating the relationship between moral reasoning and family environmental characteristics, family SES, values, extracurricular involvement, and personality characteristics, the only factors (with the exception of video game playing) displaying significant correlations with the DIT were assessments of general intelligence. This was the case even though the sample investigated possessed a restricted range of ability, but not restricted ranges on any of the other aforementioned variables. Moreover, not only did the principled moral reasoning scores correlate strongly with the cognitive variables, they also correlated just as highly with these variables as the cognitive variables did amongst themselves.

The only non-cognitive variable demonstrating incremental validity beyond general intelligence was extracurricular involvement with video games. This factor was found to be negatively correlated with principled moral reasoning. It can be speculated that the significant relationship between video game playing and the DIT moral reasoning score was revealed merely because the probability of committing a Type I error by chance was quite high due to the large number of variables involved in the study. On the other hand, the significant relationship may be due to the fact that video game playing involves little social interaction or cognitive stimulation and may replace time that could be used engaging in activities that do.

Overall, the results of this study clearly reveal that intellectually precocious youth earn advanced moral reasoning scores on the DIT. Since the findings also indicate that the DIT moral reasoning scores are strongly associated with measures of general intelligence and not associated with such variables as family environmental characteristics, family SES, values, personality characteristics, and extracurricular involvement, it can be surmised that gifted individuals earn advanced moral reasoning scores on the DIT due to their advanced levels of general intelligence. Thus, the high scores of gifted on the DIT may not be indicative of social maturity in a broad sense of the word. Moreover, the DIT is basically an assessment of general intellectual functioning.

These findings suggest a number of other important implications. The importance of replicating research is sufficiently illustrated. As indicated in Appendix C, many significant correlations were found in Study 1 but were not replicated in Study 2 and vice versa. If replication had not been carried out, misleading results may have been reported, a frequent occurrence in psychological journals today (c.f. Lykken, 1968, in press). Sampling error is the most central cause for concern. A limitation of this research, as well as to a great deal of psychological research, is the use of relatively small sample sizes. Since the standard error of correlation for small samples is quite large (e.g., the standard error for a sample size of 100 is .10) and since sample sizes in psychological research are typically less than 100, replication of findings using large samples is critical.

Second, investigators of moral reasoning using the DIT (and other objective measures of moral reasoning) should employ measures of general intelligence in future studies. Although the concept of moral reasoning may be a viable construct, the current objective measurement of moral reasoning has not, as of yet, uncovered psychologically meaningful individual differences beyond general intellectual functioning. Are all contemporary measures of moral reasoning fallible measures of general intellectual functioning? Since this may be the case, utilization of current objective moral reasoning measures should be accompanied by assessment of general intelligence.

Furthermore, additional investigations of moral reasoning, involving variables beyond those included in this study, are needed. The findings of this research indicate that general intelligence provides a partial, but incomplete, explanation for the reliable variance of DIT outcome scores. Additional research may offer insight as to what other factors, if any, are associated with scores obtained on moral reasoning measures.

In conclusion, the topic of moral reasoning is left with a number of unanswered questions. It is clear that current objective measurement of moral reasoning taps general intellectual functioning. The DIT, for instance, requires individuals to make judgments about moral issues. Hence, one who is a capable reasoner should earn a high moral reasoning score. It is unclear, however, whether or not the construct of moral reasoning goes beyond an ability to make adequate judgments. Does moral reasoning capability involve more than a general capacity to reason well? If it does, moral behavior is not necessarily a direct product of one's moral reasoning level. Perhaps moral reasoning ability is a necessary, but not sufficient condition for moral behavior. At the very least, investigators should not use the terms "moral reasoning ability" and "moral behavior" interchangeably. Thus, the specific factors associated with moral reasoning, as well as moral behavior, remain unidentified and waiting for future research.

Table 1

Reliability coefficients for instruments used in study

Instrument	Test-Retest coefficient	Coefficient alpha Study 1	Coefficient alpha Study 2
Defining Issues Test	.56		
Family Environment Scale			
Cohesion	.73		
Expressiveness	.48		
Conflict	.75		
Independence	.62		
Achievement	.57		
Intellectual-cultural orientation	.67		
Active-recreational orientation	.52		
Moral-religious emphasis	.68		
Organization	.68		
Control	.50		
Study of Values			
Theoretical	.61		
Economic	.31		
Aesthetic	.37		
Social	.45		
Political	.47		
Religious	.52		
Raven's Progressive Matrices	.49		
Activities Questionnaire			
Nonfiction reading	.14	.93	.75
School clubs	.56	.80	.60
Math/Science activities	.63	.85	.65
Video game playing	.73	.60	.64
Fiction reading	.40	.79	.67
Total participation	.58		

Table 1 continued.

Instrument	Test-Retest coefficient
Adjective Checklist	
Achievement	.33
Dominance	.41
Endurance	.46
Order	.50
Intraception	.19
Nurturance	.66
Affiliations	.49
Heterosexuality	.59
Exhibition	.38
Autonomy	.57
Aggression	.64
Change	.32
Succorance	.39
Abasement	.39
Deference	.54
Counseling readiness	.58
Self-control	.16
Self-confidence	.42
Personal adjustment	.43
Ideal self	.32
Creative personality	.16
Military leadership	.39
Masculine attributes	.22
Feminine attributes	.34
Critical parent	.52
Nurturing parent	.60
Adult	.34
Free child	.43
Adapted child	.37
High origence/low intellectence	.43
High origence/high intellectence	.34
Low origence/low intellectence	.45
Low origence/high intellectence	.04

Table 2

Mean stage % scores for gifted group

Stage	Group N=268 255		Males N=147 136		Females N=121 119	
	M	SD	M	SD	M	SD
2	7.2	5.1	7.6	4.9	6.8	5.3
	8.7	6.0	8.5	6.0	9.0	6.1
3	19.2	9.8	20.3	10.0	17.8	9.3
	19.0	10.3	20.0	10.0	17.8	10.6
4	29.4	12.4	30.0	12.8	28.7	12.0
	29.3	12.2	29.1	11.7	29.4	12.9
5A	24.7	10.2	24.0	10.0	25.5	10.3
	26.3	10.3	24.8	10.2	27.9	10.1
5B	5.4	5.0	4.7	4.3	6.3	5.5
	5.5	4.7	5.2	4.4	5.8	5.0
6	4.8	4.3	4.6	4.3	4.9	4.3
	3.8	4.3	4.3	4.5	3.2	3.9
P	34.9	12.9	33.3	12.4	36.7	13.3
	35.6	12.4	34.4	12.0	36.9	12.8

Note: Stage % scores from Study 1 (1990) top, Study 2 (1991) bottom.

Table 3

Mean P% scores of gifted, junior high average ability, and college students

	Group			Males			Females		
	N	M	SD	N	M	SD	N	M	SD
Study 1 Gifted Youth	268	34.9	12.9	147	33.3	12.4	121	36.7	13.3
Study 2 Gifted Youth	255	35.6	12.4	136	34.4	12.0	119	36.9	12.8
Average ability 12-14 year olds	57	22.4	10.6	30	22.5	10.2	27	22.1	11.1
College Freshmen	131	30.3	12.7	49	30.1	13.0	82	30.0	12.5
Junior High Norms	1,322	21.9	8.5						
Senior High Norms	581	31.8	13.5						

Table 4

Change in principled moral reasoning (mean P% scores) of gifted youth by grad

	Group			Males			Females		
Grade	N	M	SD	N	M	SD	N	M	SD
6th	5	35.0	12.3	4	34.3	14.1	1	38.0	
	4	29.8	2.1	4	29.8	2.1	0		
7th	91	31.3	11.7	55	30.6	12.4	36	32.3	10.6
	56	32.8	11.7	36	29.7	10.9	20	38.3	11.3
8th	114	35.8	13.8	56	34.4	12.7	58	37.1	15.0
	113	35.0	11.5	57	34.3	10.6	56	35.8	12.5
9th	45	38.6	11.8	24	35.4	11.8	21	42.1	11.1
	65	37.6	14.5	30	38.9	14.5	35	36.5	14.6
10th	13	40.2	11.0	8	37.9	9.3	5	44.0	13.5
	17	42.1	10.1	9	41.3	11.1	8	42.9	9.6

Note: P% scores from Study 1 (1990) top, Study 2 (1991) bottom.

Table 5

Significant Pearson correlations between P% scores and variables studied

	Group	Males	Females
ABILITY			
SAT-V	.30	.34	.25
	.45	.56	.33
SAT-M	.27	.28	.39
	.24	.29	.27
Raven	.19	.15	.26
	.21	.19	.24
FAMILY ENVIRONMENT			
Achievment	NS	NS	-.15
			-.17
Intellectual-cultural orientation	.19	NS	.18
	.12		.31
PERSONALITY			
Creative personality	.11	NS	NS
	.15		
High origence/low intellecten	NS	-.15	NS
		-.16	
ACTIVITIES			
Video game playing	-.17	NS	NS
	-.18		

Note: Correlations from Study 1 (1990) top, Study 2 (1991) bottom.

Table 6

Pearson correlation coefficients between cognitive variables and P% scores

	SAT-V	SAT-M	RAVEN	P% score
SAT-V	--	.24	.05	.25
		.61	.21	.33
SAT-M	.44	--	.43	.39
	.43		.30	.27
RAVEN	.24	.55	[.49]	.26
	.28	.43		.27
P% score	.34	.28	.15	[.56]
	.56	.29	.19	

Note: Females above the diagonal, males below.
Correlates from Study 1 (1990) top, Study 2 (1991) bottom.
Diagonal entries in brackets are test-retest reliability estimates for a subset of the entire sample (N=78, 44 males, 34 females).
$p < .05$, $r = .21$ for SAT scores
$p < .05$, $r = .15$ for Raven scores

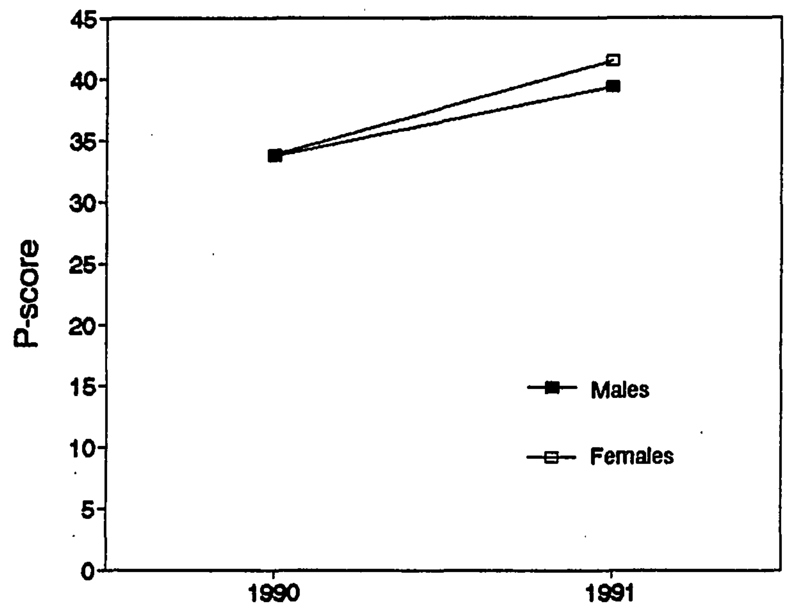

Figure 1. Changes in P% scores over one year period.

Note:

	Group (N=78)		Males (N=44)		Females (N=34)	
	M	SD	M	SD	M	SD
	33.8	14	33.7	15	33.8	13.4
	40.3	14	39.4	14	41.5	13.5

P % scores from Study 1 (1990) top, Study 2 (1991) bottom.

ENDNOTES

[1]Some exceptions are made for extremely mature 6th graders.

[2]Ability was assessed by scores earned on the Iowa Test of Basic Skills.

[3]There were no statistically significant differences between the socioeconomic status of this control group and the experimental groups.

[4]Occupational status was determined by Stevens and Hoisington's (1987) occupational prestige coding.

[5]Stage scores were not presented because the P% score is the most reliable index obtained from the DIT; thus, stage scores were not presented and compared.

[6]Since the cell sizes for 6th and 10th graders were small, these groups were not used in the analysis.

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APPENDIX A

DEMOGRAPHIC CHARACTERISTICS OF GIFTED YOUTH

	Study 1 (N=268)	Study 2 (N=255)
SEX		
Males	55%	53%
Females	45%	47%
GRADE		
6th	2%	2%
7th	34%	22%
8th	42%	44%
9th	17%	25%
10th	5%	7%
TYPE OF SCHOOL ATTENDING		
Public	94%	93%
Private	3%	1%
Church affiliated	3%	6%
SIZE OF SCHOOL		
Less than 100	1%	5%
100-200	1%	1%
201-300	9%	4%
301-500	12%	9%
501-700	28%	28%
701-900	24%	24%
901-1100	9%	18%
1101-1500	5%	1%
over 1500	5%	7%
unknown	6%	3%
RESIDENTIAL STATE		
Iowa	91%	88%
Other Midwestern state	6%	8%
Western state	1%	1%
Eastern state	1%	1%
Southern state	1%	2%
Northern state	0%	0%

(Appendix continues)

Appendix A continued.

	Study 1	Study 2
SIZE OF RESIDENTIAL COMMUNITY		
50-999	14%	15%
1,000-9,999	38%	35%
10,000-49,999	24%	28%
50,000-99,999	14%	12%
100,000-199,999	8%	8%
over 200,00	2%	2%
DIVORED PARENTS		
No	89%	91%
Yes	11%	9%
FATHER'S AGE		
31-40	28%	32%
41-50	65%	64%
51-60	6%	3%
over 60	1%	1%
MOTHER'S AGE		
31-40	47%	48%
41-50	51%	51%
51-60	2%	1%
over 60	0%	0%
FATHER'S EDUCATION		
Some high school	2%	1%
High school diploma	13%	12%
Some college	17%	9%
A.A.	3%	5%
B.S., B.A.	29%	31%
M.S., M.A.	13%	14%
Ph.D.,M.D.,J.D.	23%	28%
MOTHER'S EDUCATION		
Some high school	1%	1%
High school diploma	21%	17%
Some college	16%	11%
A.A.	5%	7%
B.S.,B.A.	32%	36%
M.S.,M.A.	17%	18%
Ph.D.,M.D.,J.D.	8%	10%

APPENDIX B

FACTOR MATRIX FOR VARIABLES IN ACTIVITIES QUESTIONNAIRE

	F1	F2	F3	F4	F5
VARIABLE					
Reading medicine/biology	.88	--	--	--	--
Reading psychology	.86	--	--	--	--
Reading about nature	.82	--	--	--	--
Reading about science	.81	--	--	--	--
Reading biography,history,philosophy	.80	--	--	--	--
Reading the classics	.80	--	--	--	--
Reading math puzzles	.76	--	--	--	--
Reading about computers	.73	--	--	--	--
Performing arts	--	.73	--	--	--
School newspaper,maganize,yearboo	--	.71	--	--	--
Technical,like stage crew	--	.69	--	--	--
Story or poetry writing	--	.58	--	--	--
School math,science,or computer clu	--	.53	--	--	--
Reading poetry or play	--	.47	--	--	--
Watching nature TV shows	--	--	.84	--	--
Watching science TV shows	--	--	.77	--	--
Nature projects	--	--	.72	--	--
Science projects	--	--	.48	--	--
Watching news and political TV shows	--	--	.47	--	--
Transformers/electrical toys	--	--	.47	--	--
Carpentry	--	--	.42	--	--
Video games in arcades	--	--	--	.81	--
Computer games	--	--	--	.73	--
Reading about elecronics	--	--	--	.41	--
Reading mysteries,adventures	--	--	--	--	.83
Reading novels	--	--	--	--	.75
Reading science fiction	--	--	--	--	.73
Factor contribution	9.77	4.33	3.84	2.71	1.82

Note: Factor loadings < .40 not reported.

APPENDIX C

PEARSON CORRELATION COEFFICIENTS BETWEEN P% SCORES AND ALL VARIABLES

	Group	Males	Females
Ability			
SAT-V	.30	.34	.25
	.45	.56	.33
SAT-M	.27	.28	.39
	.24	.29	.27
Raven	.19	.15	.26
Study of Values			
Theoretical	.05	.04	.16
	-.05	.02	-.05
Economic	-.09	-.12	.01
	-.22	-.12	-.30
Aesthetic	.09	.09	.05
	.07	.00	.09
Social	.05	.17	-.12
	.18	.09	.21
Political	-.09	-.15	.03
	-.14	-.10	-.14
Religious	-.06	-.06	-.13
	.09	.07	.08
Activities Questionnaire			
Nonfiction reading	.00	.00	.09
	.00	.17	.02
School clubs	.05	.10	-.03
	.01	.01	.05
Math/Science activities	-.07	.03	.07
	-.05	.16	.04
Video game playing	-.17	-.13	-.17
	-.18	-.01	.02
Fiction reading	.08	-.12	-.05
	.17	-.02	.03
Total participation	-.03	-.13	-.15
	.00	-.02	.03

(Appendix continues)

Appendix C continued.

	Group	Males	Females
Family Environment Scale			
Cohesion	.09	.14	.05
	.04	.04	.05
Expressiveness	.10	.01	.17
	.09	.14	.03
Conflict	-.14	-.11	-.19
	-.09	-.10	-.12
Independence	.10	.09	.08
	.09	.06	.09
Achievement	-.11	-.06	-.15
	-.09	.02	-.17
Intellectual-cultural orientation	.19	.17	.18
	.12	-.08	.31
Active-recreational orientation	.05	.09	.02
	-.02	.05	-.11
Moral-religious emphasis	-.12	-.08	-.22
	-.07	-.10	-.02
Organization	.03	.10	-.03
	-.07	.03	-.17
Control	.00	.11	-.12
	-.12	-.02	-.20
Socioeconomic status			
Mother's occupational status	.04	.02	.08
	-.05	-.07	-.03
Father's occupational status	.16	.09	.26
	.04	-.02	.10
Mother's educational level	.12	.13	.12
	.19	.13	-.11
Father's educational level	.09	.10	.10
	-.01	.08	-.14

(Appendix continues)

Appendix C continued.

	Group	Males	Females
Self-control	.02	-.06	.07
	.04	-.05	.12
Self-confidence	.01	.03	.00
	.03	.12	-.07
Personal adjustment	.01	.02	-.01
	.01	-.05	.08
Ideal self	.05	.12	.00
	-.02	.08	-.09
Creative personality	.11	.14	.10
	.15	.15	.14
Military leadership	.14	.17	.13
	.01	-.01	.05
Masculine attributes	.01	-.06	.03
	-.02	.11	-.15
Feminine attributes	.09	.00	.17
	.07	-.02	.16
Critical parent	.08	.07	.09
	.07	.18	-.06
Nurturing parent	-.07	-.03	-.10
	.00	-.05	.07
Adult	.11	.17	.06
	-.13	.00	-.05
Free child	-.02	-.03	.01
	.02	.11	-.05
Adapted child	-.08	-.12	-.05
	-.05	-.12	.02
High origence/low intellectence	-.17	-.15	-.08
	-.13	-.16	-.04
High origence/high intellectence	.13	.03	.21
	.12	.07	.13
Low origence/low intellectence	-.07	-.15	.00
	.04	-.01	.12
Low origence/high intellectence	.17	.23	.12
	.00	.15	-.10

Note: Correlations from Study 1 (1990) top, Study 2 (1991) bottom.

SECTION II: GENDER DIFFERENCES IN CAREER GOALS AMONG MATHEMATICALLY TALENTED STUDENTS

ABSTRACT

Using the Study of Mathematically Precocious Youth data set from their 10-year longitudinal study of 1,304 mathematically precocious youth, two studies were conducted to empirically identify characteristics predictive of mathematics/science career choice and high educational aspirations. Variables examined included ability (at age 13 and 17), values (at age 13), family background, attitudes toward mathematics and science (at age 13, 18, and 23), high school educational experiences, college experiences, locus of control and self-esteem, lifestyle expectations, and educational encouragement. A greater proportion of mathematically talented males than females participate in mathematics and science and hold high educational aspirations; More females lower their educational aspirations and leave the math/sciences over time while perceiving greater encouragement. Attitudes toward mathematics and science in high school were more favorable for those intending to major in math/science at age 18 and those who completed such majors than those choosing not to; rigorous high school educational experiences in mathematics and sciences and a theoretical value orientation also differentiated those individuals who completed math/science majors from those choosing to major elsewhere; and favorable college experiences characterized those males and females who pursued graduate study in math/science compared to those electing not to continue their education. Individuals completing engineering, computer science, or mathematics majors tended not to pursue graduate study. Few differences between individuals who maintain, lower, or raise their educational aspirations over the college years were found; maintainers tended to experience more college success than did decreasers, and they came from families of higher socioeconomic status than did increasers. Although females exhibited a preference for biology, and males preferred the more quantitatively oriented sciences, the career decision-making process was comparable for mathematically talented males and females.

INTRODUCTION

One of this nation's major concerns today involves the projected shortage of scientists and engineers in the next decade (Tobias, 1990). With the decreasing number of college students choosing to major in the physical sciences and mathematics (Maple & Stage, 1991; Turner & Bowen, 1990) and extreme increase in business degrees granted (Turner & Bowen, 1990), the concern is well warranted. Between 1966 and 1988, the number of college freshmen majoring in math and science decreased by one half (Green, 1989).

Women are one group within the population who are scarcely represented in the science and math communities (Dick & Rallis, 1991; Maple & Stage, 1991) and, thus, are often seen as an untapped resource. According to Datta (1985), the underrepresentation of women in these fields has been of concern since women entered the work force in large proportions. Hacker (1986) reports that of the 4 million women who have entered the work force since 1970, 3.3 million have chosen traditionally female occupations, such as nursing, secretarial, bookkeeping, and other supportive occupations. In the 1988-89 school year, for example, only 16% of all bachelor degrees earned in physics were earned by females and only 8% of all persons receiving doctoral degrees in physics that year were females (American Institute of Physics Report, 1990).

Since the mathematically gifted population has the highest potential for success in these fields (Green, 1989; Walberg, 1983) and they complete degrees in the mathematics/sciences in disproportionately high numbers (Benbow & Arjmand, 1990), it seems crucial to investigate how these trends are displayed among the extremely mathematically precocious females of our society. More importantly, efforts to investigate the characteristics of females who choose to pursue the sciences and mathematics fields, as well as those who choose to maintain high educational aspirations, seem greatly needed. This was the purpose of the current investigation.

Early findings from the longitudinal Study of Mathematically Precocious Youth (SMPY) at Iowa State University verify that mathematically gifted females (top 1%) too are greatly underrepresented in the science and math areas. Even though their academic achievement in mathematics and science is high (Benbow & Minor, 1986; Benbow & Stanley, 1982), their educational aspirations, especially those involving mathematics and science, decline considerably from the time they finish high school until their college graduation (Benbow & Arjmand, 1990). For example, Benbow and Arjmand (1990) reported, for students identified by SMPY, that at the end of high school, 62% of the mathematically gifted males and 50% of such females intended to earn a college degree in the sciences. Approximately 59% of the males and 37% of the females actually completed such majors. Thus, significant numbers of females try out majors in mathematics and science but then choose to major elsewhere; this trend is stronger for females than for males, who are more likely to remain in the sciences. A possible explanation for these findings is that mathematically talented males are more likely to display an ability and value profile congruent with studying science than are females (see Lubinski & Benbow, in press). It is also possible, because the articulation of demonstrated talent into achievement is thought to be influenced by social mechanisms (see Thompson, Detterman, & Plomin, 1991), that variables more of an environmental nature are related to these decisions as well. Thus, empirical identification of predictors of females' career decision making, in regards to level of education pursued and discipline of specialization was addressed.

This investigation was guided by Farmers's (1987) theoretical framework for conceptualizing the process of career decision making. This framework is based on Bandura's (1978) social learning theory. Specifically, Farmer (1987) claims that sets of personal, environmental, and background factors have an impact on aspiration, mastery, and career motivation. The factors investigated in this 10-year longitudinal study of mathematically talented individuals, therefore, included ability, value orientation, family backgrounds, educational encouragement, attitudes toward mathematics and science, self-esteem and locus of control, lifestyle expectations, curricula in mathematics and science, and the impact of early educational attention. Further support for the appropriateness of these variables investigated is delineated next.

Family Background and Encouragement

An association between parental educational level and children's academic performance has been reported (Langreth, 1991), and Benbow and Arjmand (1990) found that family background was related to achievement in gifted males and females. Moreover, a number of studies have emphasized the potential impact that family members can have on talented individuals (Bloom, 1985; Feldman, 1986; Fowler, 1981; Roe, 1953; Terman, 1954; Zuckerman, 1977). The family helps the child translate his/her early potential into talented performance.

Encouragement from significant others also seem to relate to choice of career. Although Langreth (1991) reported that the amount of encouragement teachers gave to students to choose science-related careers had no relation to 9th and 12th graders' proposed career choices, the amount of parental encouragement did. Dick and Rallis (1991), moreover, revealed that students choosing careers in engineering and science perceived parents and teachers as significantly more influential on their career choice than did students not pursuing such careers. Chipman, Brush, and Wilson (1985) indicated that parents are especially influential on their daughters' participation in mathematics. Yet, despite its potential salience, males are thought to receive more parental encouragement than females to achieve in mathematics and, consequently, gender differences emerge (Becker, 1981; Fox, 1977; Sadker & Sadker, 1986; but see the meta-analysis by Lytton & Romney, 1991). This supposed differential reinforcement for males is not only given by parents, but also educators (Leinhardt, Seewald, & Engle 1979).

Attitudes

Gender differences in mathematics and science career choice is often attributed to females' less positive attitudes toward these disciplines. A number of studies cite evidence that females have a lower liking for mathematics than do males (Armstrong, 1980; Brush, 1980; Fennema & Sherman, 1977; Fox, 1976; Hilton & Berglund, 1974; Keeves, 1973; Lantz, 1980; Tobias, 1978). According to Eccles (1984), girls exhibit increasingly negative attitudes toward mathematics as they approach junior high school.

In contrast, other researchers have found no gender differences in the liking of mathematics throughout the elementary and high school years (Benbow & Stanley, 1980, 1983; Ernest, 1976; Hungerman, 1967); and a few studies have even found that girls like mathematics more than their male counterparts (Paulsen & Johnson, 1983; Stright, 1960). Most importantly, the gender difference in liking mathematics has not been found among the mathematically precocious (Benbow & Stanley, 1980, 1983). Other studies have revealed a female preference for verbal areas (Arjmand, Benbow & Lorenz, 1988; Ethington & Wolfe, 1986).

Values

Gender differences with respect to preference for "people versus things" are evident not only among the general population but also among the gifted population. According to Lubinski and Benbow (in press), theoretical values are more characteristic of gifted males, while social values are more characteristic of gifted females. Since theoretical interests and values are critical factors for developing a career commitment and satisfaction (Dawis & Lofquist, 1984) to the physical sciences (Allport, Vernon, & Lindzey, 1970; Helson & Cruchfield, 1970; Hall & MacKinnon, 1969; MacKinnon, 1969), the gender differences in mathematics and science career choice may be related to the variation in such preferences.

Self-Esteem and Locus of Control

Self-esteem and locus of control have been related to achievement behaviors (Eccles, 1985). Yet Eccles (1985) reported that few studies investigating the locus of control and self-esteem of gifted individuals exist. The ones that do present mixed results. Some researchers report that gifted females have lower self-confidence than gifted males (Fox, 1982; Terman, 1925). Tidwell (1980), on the other hand, found no gender differences. In addition, no gender differences on measures of locus of control have been revealed (Tidwell, 1980; Tomlinson-Keasey & Smith-Winberry, 1983). Given these results, it is not clear whether a gender difference exists in terms of locus of control and self-esteem among the gifted and whether these factors might even relate to the development of a gender difference in mathematics/science achievement. These possible correlates of achievement in mathematics and science were, therefore, important to evaluate.

Pre-College Curricula

Number of mathematics and science courses taken in high school has been found to exhibit a strong relationship with choice of college major as well as career choice (Berryman, 1985; Ethington & Wolfe, 1988). Berryman (1985), for example, found that women who do choose a quantitative field of study have taken advanced science and mathematics courses in high school. Using results from a pilot study, Sells (1973) argued that inadequate high school mathematics preparation placed a serious constraint on a woman's choice of undergraduate major in college (also see Ethington and Wolfe, 1988). Sells (1980) concluded, therefore, that women are denied certain career options because they do not take enough mathematics in high school (e.g., West & Gross, 1986). She identified the mathematics background of women as the "critical filter" that screens out females from engineering and science majors.

High school science preparation may play a similar role. Indeed, girls do not take as many high school courses in science as boys (Casserly, 1980; Dornbusch, 1974; Ernest, 1980; Fennema, 1980; Fox & Cohn, 1980; Jacobs & Wigfield, 1989; Pallas & Alexander, 1983). Moreover, Benbow and Minor (1986) reported that within a large gifted group, 74% of boys completed an entire high school science sequence, while only 56% of girls did the same.

Special Educational Opportunities

Bloom (1985) describes special interventions as having a possible beneficial relationship with achievement. Indeed, among exceptionally able females who were achieving highly in the math/sciences, special attention and interventions occurred frequently during the years in which they translated giftedness into high achievement (Montgomery & Benbow, in preparation). Moreover, Casserly (1975) studied 12 high schools chosen for their high proportion of girls enrolled in mathematics and physical science courses. These schools were found to have teachers who demanded high-level performance of both girls and boys and who actively recruited girls to participate in the courses. In addition, an intervention program attempting to increase 7th-grade gifted girls' participation and acceleration in mathematics resulted in greater acceleration by their participants. Moreover, the successful participants subsequently reported more favorable educational experiences, higher educational aspirations, and more ambitious career goals than did the other females studied (Fox, Benbow, & Perkins, 1983).

Ability

Maple and Stage (1991) concluded that standardized test scores are an important influence on high school educational experiences involving mathematics and science. Ability is also an important component of vocational satisfactoriness (Dawis & Lofquist, 1984). Since Benbow (in press) found differences in academic achievement in math/science among students in the bottom and top quartiles of the top 1% in mathematical ability, the relationship of ability to career decisions in math/science warranted investigation. Thus, SAT-V and SAT-M scores earned in 7th/8th grade and at the end of high school by the participants were investigated. No other ability measures were available.

Summary

A number of potential factors could be related to the tendency for most mathematically talented females, unlike such males, to choose majors in fields other than mathematics and science. They include family background, educational encouragement, attitudes, math/science curricula, locus of control and self-esteem, lifestyle expectations, ability, values, and educational experiences. It was hypothesized that these variables would differentiate between those highly able females who pursue mathematics and science and those who do not. Using a data set from a 10-year longitudinal study, two studies were conducted in order to determine how the above variables characterize mathematically talented females making different career decisions. These variables were examined at various times in the females' academic lives, times when career decisions are made. To assess gender differences, mathematically talented males also were characterized.

METHOD

Subjects

Students in Cohort 1 of SMPY's longitudinal study were investigated. They were drawn from SMPY's first three talent searches held in 1972, 1973, and 1974. In those searches, 7th and 8th grade students in Maryland were eligible to participate if they had scored in the upper 5% (1972) or upper 2% (1973, 1974) nationally on any standardized mathematics achievement test. Qualified students then took the College Board Scholastic Aptitude Test - Mathematics (SAT-M) and, in 1973, also the Scholastic Aptitude Test - Verbal (SAT-V). The distribution of SAT-M and SAT-V scores for the 7th and 8th-graders in the talent search was similar to that of high school students (Benbow, 1988). Although the SAT was designed to measure developed mathematical and verbal reasoning abilities of above-average high school students (Donlon, 1984), Benbow and Stanley (1981, 1983) concluded that they do so especially well for their SMPY participants.

Using the procedure outlined by Angoff (1971), SAT scores earned in 7th-grade were adjusted upward to be comparable to 8th-grade scores. Participants were required to have scored at least 390 on SAT-M or 370 on SAT-V as a 7th or 8th grade student in order to be included in Cohort 1 of the SMPY longitudinal study. According to these SAT criteria, the selected students (N=2,188) scored as well as the average 11th and 12th grade female does on SAT-M or SAT-V (Admissions Testing Program, 1979) and represent approximately the top 1% in overall intellectual ability.

Procedure

Participants in Cohort 1 completed the following three questionnaires: an initial talent search questionnaire, an 8-page survey assessing the student's achievements in high school, and a 24-page questionnaire assessing achievement in college and one year post college graduation (see Appendix A for a description of the variables studied).

Talent Search questionnaire. At age 13, all participants completed a 3-page Talent Search questionnaire. The survey consisted of basic family background questions, as well as measures of attitudes toward school.

After-high school survey. The first follow-up questionnaire was mailed to the participants in the late fall after their expected date of high school graduation. The 8-page questionnaire was accompanied by an offer of monetary compensation ($5 or

$6). Reminder letters were administered if the questionnaire was not returned after six weeks upon receipt. Those not having responded by the following summer were telephoned. The overall response rate exceeded 91% of the total sample. The sample consisted of 1,229 males and 767 females, with a total sample size of 1,996. Response rates did not covary with sex or ability (Benbow & Stanley, 1982).

After-college survey. The second follow-up questionnaire was mailed to the same students, with no offer of monetary compensation, in the fall of the year they turned 23 (Benbow & Arjmand, 1990). Similar follow-up techniques as used in the after-high school follow-up were used with this questionnaire. The response rate was 65%. In order to increase this rate, nonrespondents were contacted by telephone and asked to respond to 20 critical questions. This increased the overall response rate to about 70%. The sample of Cohort 1 used for this study included 817 males and 487 females, with a total sample size of 1,304.[1] Respondents did not differ significantly from nonrespondents on the following variables: talent search SAT-M score, high school SAT-M and SAT-V scores, college attendance, quality of college attended, parental educational levels, number of siblings, and father's occupational status (Benbow & Arjmand, 1990).

Statistical Analyses. The two related studies to be reported were performed using the above questionnaire data. In all comparisons, students were placed into groups and then contrasted. Data are reported in terms of means, standard deviations, medians, proportions, and effect sizes. A difference was considered statistically significant if $p \leq .05$. Due to the large number of variables investigated and large sample sizes in some of the group comparisons, it was felt that significance testing alone was not adequate to identify useful correlates/predictors of educational/career choice. Thus, effect sizes were calculated. For means, the effect size is d; $d = [X_1 - X_2]/SD$, average SD used (Cohen, 1988). Differences between proportions are represented by the effect size, h. H is determined by an arcsine transformation of each proportion and then calculating the difference. Cohen (1988) arbitrarily classified effect sizes as small if $.2 \leq h, d < .5$, medium if $.5 \leq h, d < .8$, and large if $h, d \geq .8$. He describes a medium effect size as the "degree of relationship [that] would be perceptible to the naked eye of a reasonably sensitive observer" (p. 80) and places a large effect size in the category of "about as high as they come" (p. 81). Levels of significance for effect sizes computed for group comparisons are noted in the individual tables.[2]

The power to detect a medium effect size for each of the group comparisons in Study 1 were as follows: at the end of high school, greater than .995 for both males and females; at the end of college, .99 for both males and females; at age 23 (beginning of graduate school), .91 for males and .80 for females. The power to detect a medium effect size for the group comparisons in Study 2 were as follows: maintainers versus decreasers,.96 for females, greater than .995 for males; and maintainers versus increasers, .84 for females, .99 for males.

STUDY 1

Purpose and Design

The first study was conducted in order to identify the characteristics of those mathematically talented males and females who decide to pursue mathematics and science careers and those mathematically talented individuals who over time choose not to do so. These males and females were studied at three junctures in their academic careers: at the end of high school, at the end of college, and at age 23 (beginning of graduate school). These are all times when important career decisions are made and when females disproportionately choose to exit from the math/science pipeline.

Results

Career decision point 1: End of high school. The first set of comparisons involved characterizing the individuals at the end of their high school career, a time point when considerable career decision-making has been completed. Members of Cohort 1 were placed in one of four groups and then compared. Males and females were investigated separately. For females, members of the first group were identified as those females intending to major in mathematics or science (N=410). The second group consisted of the females intending to pursue majors in other areas (N=260). Males who chose math/science majors (N=781) and the males choosing other fields (N=329) also were studied. Approximately 50% (410 out of 787) of the females in Cohort 1 chose to major in the mathematics/sciences at age 18, while a greater proportion of the males (62%) (781 out of 1,253) made the same decision ($h = .24$, $p < .01$).

Ability. The ability of the four groups in terms of SAT-V and SAT-M scores earned in 7th/8th grade and at the end of high school was first examined. Means and standard deviations for all groups are shown in Table 1. Both female groups obtained comparable scores. When comparing the two male groups, however, mathematical ability in 8th grade and at the end of high school favored the math/science majors (d = .23, .33, respectively). Sex differences in 8th grade and high school SAT-M scores, favoring the males, also were revealed (d = .55, .70 for math/science majors; .40, .41 for non-math/science majors, respectively). Although differences were evident, it seems that all groups displayed adequate mathematical ability to succeed in the mathematics/science areas.

Table 2 provides the means, standard deviations, and effect sizes for the other variables investigated at age 18. In general, all four groups held comparable background characteristics and attitudes toward mathematics in 7th grade. Attitudes expressed at the end of high school, however, favored the males and females who chose math/science majors at that time (mean effect size = .34, .39, respectively). In addition, those individuals indicating an intention to major in mathematics or science reported participating in more rigorous high school educational experiences than did those non-math/science majors (d = .20 for males; .21 for females). When comparing male and female math/science majors, few differences were revealed. Females expressed a stronger preference for biology, while males preferred the more quantitatively oriented sciences (d = .38, .52, respectively). In terms of values, males preferred theoretical, economic, and political orientations (d = 1.14, .84, .86, respectively), while females were characterized by aesthetic, social, and religious value orientations (d = 1.06, 1.03, .52). High school educational experiences favored the males (mean effect size = .27), as did ability. These trends suggest that males embarking upon a major in math/science have a slight advantage over females with the same goals in terms of training, ability, and values.

Career decision point 2: End of college. Approximately 62% of the males and 50% of the females in Cohort 1 indicated at age 18 that they were planning to major in mathematics or science, while only 37% of the females and 59% of the males actually completed majors in these fields (Benbow & Arjmand, 1990). That is, a greater proportion of males (73%) intending to pursue math/science college degrees at age 18 actually completed that major as compared to only 49% of the females doing the same (h = .50, p < .01).

The second set of comparisons involved female (N=123) and male "persisters" (N=360) (those individuals who chose a mathematics or science major at age 18 and actually completed that major) and female (N=134) and male "nonpersisters" (N=150) (those individuals who chose a mathematics or science major at age 18, but for some reason, later elected to major in another discipline). This design allowed for an attempt to characterize males and females who carry out their early interest in mathematics or science through college and those who change their focus sometime during the college experience.

Ability. As indicated in Table 1, SAT-V and SAT-M scores earned by the two groups of females were similar, with the exception of SAT-M scores earned at the end of high school. Female persisters earned higher SAT-M scores than did the female nonpersisters (d = .52). Similar trends were revealed for the two male groups, with the differences in mathematical ability in 8th grade, as well as at the end of high school, favoring the persisters (d = .33, .43, respectively). Sex differences in 8th grade and high school mathematical ability, favoring the males, also were evident (d = .56, .82 for persisters; .40, .63 for nonpersisters, respectively).

Persisters vs. Nonpersisters. Means, standard deviations, and effect sizes for the other variables studied are given in Table 3. In addition to differences in high school math/science attitudes (mean effect size = .26 for males; .28 for females) and math/science attitudes expressed at age 23 (mean effect size = .54 for males; .32 for females), there were differences between persisters and nonpersisters, irrespective of gender, in high school educational experiences (mean effect size = .32 for males; .30 for females). Although it was not statistically significant (few individuals had value scores), female persisters reported a greater theoretical value orientation than did female nonpersisters (d = .37). Moreover, both male and female persisters reported more favorable attitudes toward math and science and more rigorous educational experiences than did the nonpersisters.

In addition, the quality of colleges attended by the participants as undergraduates was examined. Using Astin's (1977) ranking of United States colleges and universities (lower numbers indicating greater prestige), results revealed that persisters attended schools that were significantly more prestigious than those attended by nonpersisters, $X^2(N = 499) = 5.9$, $p < .01$ (for males); $X^2(N = 244) = 7.9$, $p < .005$ (for females). Persisters also perceived receiving more encouragement than did the nonpersisters (mean effect size = .26 for males; .24 for females). No other sizable differences were found between persisters and nonpersisters.

Male vs. Female Persisters. Moreover, few differences were revealed between the male and female persisters. Attitudes toward mathematics and science expressed at age 23 did favor the males (mean effect size = .40). In addition, male persisters attended significantly more prestigious colleges and universities than did female persisters, $X^2(N = 485) = 4.6$, $p < .05$. Males were characterized by greater theoretical, economic, and political value orientations (d = .97, .92, .82, respectively), and females were characterized by greater aesthetic, social, and religious preferences (d = .96, .95, .68). Female preference for the biological sciences (d = .43) and male preference for physics (d = .45) also were evident. In terms of employment expectations, females placed more importance on part-time careers (d

= .69), while males indicated a preference for full-time careers (d = .98). Also, although the differences were not significant, females tended to perceive receiving more educational encouragement than did the males. Overall, however, males and females who chose to major in mathematics or sciences at age 18 and actually completed the major tended to be more alike than different.

Reasons for Pursuing/lLeaving Math/Sciences. Reasons given by the persisters and nonpersisters for pursuing or leaving math/science majors were investigated. In this context, it is interesting to note that 51% of the female nonpersisters and 43% of the male nonpersisters reported that they had not changed majors during their college careers even though they all had reported to SMPY at age 18 an intention to pursue math/science majors. This seems to reveal that the commitment to the mathematics and science fields expressed at age 18 by many of these individuals must have been weak and might explain their departure from the math/science pipeline. Those nonpersisters who did indicate changing majors revealed that the single most important reason for making the transition was due to a change in interest. Forty-one percent of the females and 35% of the males expressed this opinion. Other reasons included: few career opportunities/prospects for future earnings poor (18% males; 14% females) and coursework not what I expected (8% males; 16% females). From the other possible choices given (see Appendix A), none were chosen by more than 9% of either the males or females.

On the other hand, the top three reasons given by the persisters for pursuing math/science majors were: interest and enjoyment (39% males; 50% females); status and prestige (16% males; 17% females); and challenge/use of abilities to the fullest (18% males; 11% females). Thus, interest seems to be a primary determinant of college major among those with high mathematical ability.

Reasons for Changing into Math/Science Major. A final analysis performed for this career decision period involved those males and females who changed into a math/science major during their college experience and successfully completed such a major. Of the individuals completing a major in mathematics or science, 25% of the females and 27% of the males entered the math/science pipeline after the beginning of college. Among those, 60% of the females and 44% of the males had been undecided with respect to college major at age 18.

Means, standard deviations, and effect sizes for these groups are provided in Table 5. In general, no differences between these groups and the persisters were revealed. When asked the single most important reason for choosing a math/science major, both males and females indicated the same top three responses as expressed by the persisters.

Career decision point 3: Age 23 (beginning of graduate school). After deciding upon a major in college, the next principal career decision for these talented males and females is whether to pursue graduate training. Given the focus of this paper, only those individuals who chose a mathematics or science major and actually completed it were investigated at this career decision point. They were broken down into four groups: those persisters who pursued graduate study in mathematics or science (N = 47 for females; N = 159 for males) and those persisters who did not continue their education beyond the bachelor degree (N = 51 for females; N = 124 for males). Thus, it was evident that a somewhat greater proportion of Cohort 1 male persisters (56%) pursued graduate school in the math/science areas than did the female persisters (48%) (h = .16, p < .05).

Ability. In terms of ability, a greater number of differences were revealed between male persisters pursuing graduate study and those who did not than between the two female groups (see Table 1). Those males who were continuing their education displayed stronger mathematical ability in 8th grade and in high school than did the males not pursuing graduate training (d = .47, .58, respectively). In addition, high school verbal ability favored the graduate school students (d = .42). The only ability difference among the female groups involved high school verbal ability, with the female persisters who were pursuing graduate school earning higher scores (d = .47). Sex differences in mathematical ability displayed in 8th grade and high school, favoring the males, also were revealed (d = .54, .66 for graduate school attendees; .41, .63 for non-attendees).

Persisters Pursuing Graduate School vs. No Graduate School. Table 5 provides the means, standard deviations, and effect sizes for the other variables investigated at this juncture. Irrespective of gender, college educational experiences favored the persisters pursuing graduate training (mean effect size = .55 for males; .40 for females;). Although all groups attended comparably prestigious undergraduate institutions, the persisters pursuing graduate study had experienced more success in college than did the persisters not continuing their education. No other sizable differences were noted.

Male Persisters Pursuing Graduate School vs. Female Persisters Pursuing

Graduate School. When comparing the male and female persisters who pursued graduate school, few differences were found. Female preference for the biological sciences was again evident (d = .74). In addition, males placed more importance on full-time careers (d = .78), while females placed a higher value on part-time careers (d = .96). In terms of values, males reported greater theoretical, economic, and political value orientations (d = 1.03, .92, .93), while females preferred aesthetic, social, and religious orientations (d = .90, .99, .61). Although differences were not significant, males tended to participate in more rigorous high school educational experiences and expressed more favorable attitudes toward mathematics and science when compared to the females. They also attended more prestigious colleges than did the females. Females, however, indicated receiving more educational encouragement than did the males.

Engineering, Computer Science, and Mathematics Majors. Further investigation of the characteristics of persisters pursuing graduate study and those who did not involved the specific college majors of these individuals. Of the persisters not pursuing graduate school, 86% of the males and 61% of the females had majored in engineering, computer science, or mathematics. Given that career opportunities are readily available in these areas for individuals completing only a bachelor degree, their decisions are understandable.

Taking out the persisters not pursuing graduate training who were engineering, computer science or mathematics majors, the means, standard deviations, and effect sizes were recomputed for the remaining individuals in these groups (see Table 6). One of the few differences found when removing the engineering, computer science, and mathematics majors was in terms of college experiences. Number of math credits and courses taken was much higher for the nonpersisters when the engineering, computer science, and mathematics majors were left in the analyses. In addition, the individuals who majored in other science areas attended more prestigious undergraduate institutions than did the math/engineering group although the differences were not statistically significant.

One final interesting result involves the background characteristics of these groups. Results revealed that male persisters pursuing graduate study came from families of higher socioeconomic status (in terms of father's educational level and occupational status) than did persisters not pursuing graduate study (d = .47, .79, respectively) (see Table 5). The difference was even greater when the engineering, computer science, and mathematics majors were taken out of the analysis (d = .62 for father's educational level, 1.02 for father's occupational status) (see Table 6). These background differences were not evident when comparing the female groups.

Discussion

The purpose of this study was to determine characteristics of mathematically talented males and females who pursue the mathematics and science fields. These individuals were examined during three periods when important career decisions are made: at the end of high school, at the end of college, and at age 23 (beginning of graduate school). Findings from this study revealed that at all three junctures, a greater proportion of females than males have elected to leave the math/sciences. Thus, the claim that mathematically gifted women are underrepresented in the science and math communities is confirmed with these data. The degree of underrepresentation also became greater as these individuals progressed through their academic careers.

Although there were consistent differences between individuals choosing to leave the math/sciences at various stages, most of these differences were small. The differences were mainly in terms of attitudes and educational experiences. At the end of high school, the only sizable differences found between mathematically able males and females who chose to major in mathematics or science at age 18 and those who did not involved attitudes toward mathematics and science expressed in high school, but not in 7th grade. Findings reported at the end of college indicated that those individuals who pursued and completed math/science majors participated in more rigorous high school educational experiences and had more positive attitudes toward mathematics and science than did the individuals not completing math/science majors. In addition, for females a greater theoretical value orientation characterized those who persisted in mathematics and science majors. Although the nonpersisters did not indicate that the reason for leaving a math/science major was due to lack of adequate preparation but rather because of change in interest, these results suggest that the persisters were much more adequately equipped to succeed in these fields. Nonetheless, support also was found for the notion that many of these individuals seemingly choose to pursue other areas that are more congruent with their values and interests.

At the last career decision point studied, age 23 (beginning of graduate school), findings revealed that those individuals pursuing graduate study in mathematics or science had participated in more successful college experiences than did individuals not continuing their education. Moreover, high school verbal ability was significantly stronger for the males and females who attended graduate school. Data on the specific majors of the individuals studied at this time point suggested that a large proportion of those not pursuing graduate school majored in engineering, computer science, and mathematics, areas in which a higher degree is not necessary for career opportunities.

When comparing males and females at each career decision-making point, few differences were found. Gender differences that were consistent across comparisons include stronger mathematical ability, greater theoretical, economic, and political value orientations, lower aesthetic, social, and religious value orientations, and more rigorous high school educational experiences for males. These results suggest that males pursuing mathematics and science possess values more congruent with pursuit of scientific careers and have an early advantage in terms of preparation and ability, over females with the same career goals . Other consistent gender differences revealed were female preference for biology and male preference for physics, and females perceived receiving more educational encouragement than did the males.. In addition, females placed a higher importance on part-time careers, while males felt that full-time careers were more important. Nonetheless, whatever the factors that play a role in math/science persistence, it seems that for the most part they are affecting both males and females similarly.

STUDY 2

Purpose and Design

The second study took a somewhat different tact. Its focus was on educational aspirations and changes in such aspirations over time. In this regard, it is known that more mathematically talented females lower their educational aspirations during the college years than do such males (Benbow & Arjmand, 1990). At the cessation of high school, aspirations to earn a doctoral degree were reported by 39% of the males and 37% of the females in Cohort 1. At the end of their college experience, however, the proportion of females lowering their aspirations was greater than the proportion of males making the same decision. Forty-six percent of the females lowered their aspirations, while only 37% of the males did the same (h = .18, p < .01). Moreover, a greater proportion of males (17%) raised their educational aspirations, hoping to earn a doctorate, while only 13% of the females made the same choice (h = .11, p < .05). Thus, compared to males, a greater proportion of females in the pool of doctorate-seeking candidates lowered their educational aspirations and fewer females replaced them (by raising their aspirations). The purpose of this study was to empirically identify characteristics of mathematically gifted females who maintain, lower, or raise their educational aspirations during the time they spend in college and if these same characteristics also apply to males. Since almost all of the members of Cohort 1 had obtained a bachelor degree, this investigation focused on educational aspirations to earn a doctorate.

Female members of Cohort 1 were placed into three groups: those who indicated at the end of high school that they hoped to obtain at least a doctoral degree (some indicated preference for post-doctoral study as well) and still held the ambition at the end of college (N = 67), those who did not hold this aspiration at the end of high school but by the end of college did (N=49), and those who lowered their educational aspirations by the end of college (N = 184). Male members of Cohort 1 who indicated the same educational aspiration at the end of high school were also identified as maintaining their aspirations (N = 173), raising their aspirations (N=109), or lowering their aspirations (N = 301).

Results

Ability for maintainers, decreasers, and increasers are provided in Table 1. For females, SAT-V scores earned in 8th grade favored the female maintainers, although the differences were not statistically significant. In addition, maintainers earned significantly higher SAT-V scores in high school than did those females raising their aspirations (d = .41). When comparing the male groups, similar trends were revealed. Mathematical ability of maintainers, decreasers, and increasers was similar when making within sex comparisons. Across sex comparisons, however, did reveal differences in mathematical ability. Male maintainers, decreasers, and increasers exhibited stronger 8th grade and high school mathematical ability than did the females (d = .64, .70 for maintainers; .56, .68 for decreasers; .75, .76 for increasers, respectively).

Means, standard deviations, and effect sizes for the other variables studied are provided in Table 7 for females and Table 8 for males.

Maintainers vs. Decreasers. Results revealed that the maintainers and decreasers had similar background characteristics, values, attitudes, high school educational experiences, and encouragement. Differences, however, appeared in college educational experiences. Maintainers reported having a more successful college experience than did decreasers (mean effect size = .38 for males; .36 for females). Male maintainers also attended more prestigious schools than did the decreasers, $X^2(N=315) = 5.4$, $p < .05$. In addition, lifestyle and employment expectations expressed at age 23 differed between the groups (mean effect size = .44, .58 for males; .50, .34 for females, respectively). Surprisingly, male and female decreasers placed less importance on marriage and family than did maintainers.

In regards to their college majors, results revealed that 21% of the male decreasers and 8% of the female decreasers were engineering, computer science, or mathematics majors. (This finding may explain why the decreasers took more math credits and courses in college than did the maintainers.) Since career opportunities with a bachelor degree in these areas are abundant, it may be that these individuals lowered their aspirations to earn a doctorate because a higher degree was just not seen as necessary to obtain their career goals.

The decreasers who were engineering, computer science, and mathematics majors were taken out of the "decreasers" group, and means, standard deviations, and effect sizes were recomputed. These data are shown in Table 7 for females and Table 8 for males. The differences between the maintainers and the non-math/engineering/computer science decreasers in terms of college educational experiences were still apparent and even larger, favoring the maintainers. Lifestyle and employment expectations, however, were now similar between these two groups. That is, both male and female decreasers who were not engineering, computer science, or mathematics majors placed more importance on marriage and family than did decreasers who had majored in the aforementioned areas. This is an indication that individuals pursuing engineering, computer science, or mathematics careers without postgraduate education are still career-oriented even though they lowered their educational aspirations.

Maintainers vs. Increasers. Comparisons between maintainers and increasers revealed few differences (see Tables 7 and 8). One of the few differences found involved family background characteristics (mean effect size = .59 for males; .38 for females). The maintainers came from homes with more highly educated parents than did the increasers. This difference, however, did not affect the status of colleges attended by the increasers. (No differences between prestige of undergraduate institutions attended by maintainers and increasers were found). Also, female maintainers reported receiving more encouragement for attending college and graduate school than did the female increasers (mean effect size = .30). This may help explain why the increasers initially did not hold high educational aspirations. Otherwise, the two groups were similar in terms of the variables examined.

Males vs. Females. Few differences were revealed when making across sex comparisons among maintainers, decreasers, and increasers. Although most variables tended to favor the males, the same trends found among the male groups were also apparent among the females. Moreover, males and females attended comparably prestigious colleges. Differences that were revealed consistently across all group comparisons included the female preference for biology (d = .20 for maintainers; .38 for decreasers; .20 for increasers) and the male preference for physics (d = .43 for maintainers; .36 for decreasers; .72 for increasers). In addition, females placed more importance on part-time careers (d = .81 for maintainers; .53 for decreasers; .53 for increasers), while males felt that full-time careers were crucial (d = .66 for maintainers; .45 for decreasers; .28 for increasers). In terms of values, males were characterized by greater theoretical, economic, and political value orientations (d = .97, .62, .84 for maintainers; .44, .95, .37 for decreasers; 1.3, 1.1, .58 for increasers, respectively), and females reported greater aesthetic, social, and religious value orientations (d = .97, 1.1, .29 for maintainers; .81, 1.2, .06 for decreasers; , 64, .81, .75 for increasers, respectively). Females also perceived receiving more educational encouragement than did the males.

Overall, few gender differences among maintainers, decreasers, and increasers were found. Thus, the decision-making process involved in making choices about educational aspirations is comparable for males and females.

Discussion

This study examined the characteristics of mathematically talented males and females who maintained, lowered, or raised their educational aspirations to earn a doctoral degree during the college years. Findings from this study indicated that the proportion of males who maintained or raised their educational aspiration is higher than the proportion of females making the same decisions. Moreover, a greater proportion of females lowered their high aspirations when compared to males. These data support the contention that more mathematically talented males are pursuing postgraduate education as compared to such females and differences become larger as these individuals progress through their academic careers.

When comparing males and females who maintained or lowered their educational aspirations, few differences up until the college years were found. Differences, however, did emerge during college, with the maintainers experiencing more favorable college success than the decreasers. Interestingly, maintainers valued full-time careers, marriage, and children more highly than did those individuals lowering their aspirations. The hypothesis that many of the individuals lowering their aspirations are entering fields such as engineering, computer science, and mathematics where a doctoral degree is not needed to be successful and to earn a considerable income was confirmed. When taking these individuals out of the pool of "decreasers", values toward marriage and family interestingly enough did not differ between the maintainers and decreasers. Family planning and expectations, therefore, cannot be viewed as an explanation of the lowering of educational aspirations of females.

Differences between maintainers and increasers, on the other hand, were quite opposite of those found between maintainers and decreasers. The most prominent difference was family background. Maintainers were characterized by higher socioeconomic status than were the increasers. Differences in college experiences, however, were not found. Perhaps upon entering college, those individuals raising their educational aspirations came to the realization that opportunities to continue their education beyond the bachelor degree were possible. Perceptions of encouragement may also offer an explanation since the females who raised their aspirations reported receiving less encouragement for their educational pursuits than did female maintainers.

Gender differences within the groups of maintainers, decreasers, and increasers of educational aspirations were few. The differences mirrored the gender differences found in Study 1. Again, these results indicate that the career decision-making process is similar for males and females.

GENERAL DISCUSSION

This 10-year longitudinal study investigated characteristics of mathematically talented males and females who pursued the mathematics and science fields and who held educational aspirations to earn a doctoral degree during the time spent in college. The purpose of Study 1 was to profile males and females who: (1) chose math/science majors at age 18, (2) pursued math/science college majors and completed them, and (3) pursued graduate study in these fields. These individuals were contrasted with mathematically talented males and females who did not make these career choices.

In general, favorable high school attitudes toward mathematics and science characterized those individuals who chose a math/science major at age 18 and those who completed such majors; rigorous high school educational experiences in the mathematics and sciences, in addition, differentiated those individuals who completed math/science college majors and those choosing to major elsewhere. For females, a greater theoretical value orientation characterized those who pursued mathematics and science majors.[3] Favorable college experiences, by contrast, characterized those males and females pursuing graduate study in math/science areas compared to those electing not to continue their education. These findings are indicative of an interdependent nature of factors related to career decision-making. That is, strong theoretical value orientation and mathematical reasoning ability may lead to more favorable attitudes in high school, which in combination may relate to completing a more rigorous high school math/science curriculum. In turn, adequate high school preparation in mathematics and science should influence the success experienced in college and subsequent attitudes toward mathematics and science, which affect not only completion of a math/science major but also graduate school attendance. Thus, these data are illustrative of how career decision-making is continuous; later decisions build upon and are influenced by earlier decisions.

Some ability differences were found between individuals who pursued the mathematics or science fields. Yet, it was felt that all groups demonstrated the potential to succeed in these areas since their general ability level and specific quantitative skills are greater than the typical physical scientist (see Lubinski & Benbow, in press). Attitudes, values, and interests may play a more pivotal role in the career decision-making process of mathematically talented individuals than does ability. For example, interest was the single most important reason for leaving a math/science major or for pursuing one. Nonetheless, in both this study and in Benbow (in press) the most mathematically talented are more likely to pursue careers in math/sciences.

Educational experiences have been thought of as important in persistence in mathematics and science. According to Sells (1980), the pre-college mathematical background (e.g., courses such as calculus) acts as a "critical filter" for screening out females from mathematics and science majors. Based on the results from this investigation, the strength of this claim is questioned. Indeed, those who completed math/science majors had more often taken calculus in high school than those who choose to major elsewhere. Nonetheless, 40% of the Cohort 1 females who completed a math/science college major reported not taking calculus in high school; almost 60% of those students moving into a math/science major had not taken calculus. Moreover, 28% of the females pursuing graduate study in the mathematics and sciences reported no experience in high school calculus. Since this large proportion of females were able to pursue the mathematics and sciences without taking calculus in high school, it seems that "critical filter" may be an inappropriate descriptor of pre-college math curriculum when applied to the mathematically talented. It might be a filter but not a critical one. Moreover, high school physics is evidently not a "critical" filter. Results revealed that participation in high school physics courses differentiated between those individuals who pursued mathematics or science and those who did not to a lesser extent than did taking high school calculus.

These data also suggest that the type of math or science field pursued may play a role in whether or not one will partake in graduate study. Interestingly, males and females who pursued engineering, computer science, or mathematics did not, for the most part, pursue graduate education. The fact that a higher degree beyond a bachelor degree in engineering, computer science, or mathematics is not a necessity for career opportunities may explain these trends. Yet, lifestyle expectations expressed by these individuals were also quite different from the other mathematically talented males and females. Finding the right person to marry and having children were not as important to the individuals majoring in engineering, computer science, and mathematics.

The characteristics of males and females who maintained, lowered, or raised educational aspirations to earn a doctorate during their college experience was also investigated. This was the purpose of the Study 2. Few differences between these groups were evident. Only two were noteworthy. Maintainers experienced greater college success than the individuals lowering their aspirations, and maintainers were characterized by higher socioeconomic status than were the individuals raising their aspirations.

Results obtained from both studies revealed some consistent trends in terms of gender differences. First and foremost, the data were consistent with the claim that a greater proportion of mathematically talented males, as compared to females, choose to pursue math/science careers and do so more vigorously. Moreover, more males choose to maintain high educational aspirations as compared to females. Thus, highly able females when compared to males are underrepresented in the sciences, and this underrepresentation increases with educational level, as well as with the quantitative nature of the field (also see Lubinski & Benbow, in press).

Although the amount of perceived encouragement from others was not significantly different between the males and females, females consistently reported receiving a greater amount than did the males. This trend contradicts the claim that males are thought to receive more encouragement than females to achieve in mathematics (Becker, 1981; Fox, 1977; Sadker & Sadker, 1986) and is consistent with Lytton and Romney (1991). These data do not, however, reveal whether females are more apt to acknowledge receiving encouragement or whether they actually did receive more than their male counterparts.

Gender differences in mathematical ability also were prominent. For all groups compared, males exhibited stronger mathematical ability than did the females. These differences were evident in 8th grade and at the end of high school (see Benbow & Stanley, 1980; 1983 for presentation and further discussion on this gender difference). Consistent with other reports on this population (see Lubinski & Benbow, in press), it was shown that males also hold value and ability profiles more congruent with pursuing scientific careers . In addition, males in these studies participated in more rigorous high school educational experiences than did the females. Thus, with stronger mathematical ability, more congruent values, and more math/science training, males are apparently better equipped to succeed in the math/science fields at every stage. They also hold stronger commitment to full-time careers. This might help explain the greater attrition of females with increasing age.

In conclusion, the most prominent finding of this research might be the gender differences that were not found. For instance, investigation of locus of control and self-esteem indicated no gender differences. Even though Eccles (1985) contends that these characteristics are related to achievement behavior, this was not the case in the present research. Not only were these factors similar among genders, they also did not differentiate between individuals making different career/educational decisions.

Although this investigation was limited in terms of the less-than perfect response rate and partial reliance on self-reported data, this research was guided by the requirement of total evidence (a rule in philosophy of science that requires examination of all pertinent information when evaluating a scientific question) (Carnap, 1950). A large number of possible factors, all available ones, relating to the career decision-making process were examined. Considering the total evidence, it is concluded that the career decision-making process does not differ for males and females. That is, the various factors that may be related to career decisions regarding the mathematics and sciences and educational aspirations, whether they are attitudes toward mathematics and science, value orientation, ability, high school educational experiences, or college experiences, affect males in a similar fashion to the way they influence females. Nonetheless, males compared to females were better equipped to pursue a math/science major and, indeed did so to a greater extent. Conclusions drawn from this study suggest that interventions carried out to increase the proportions of mathematically talented individuals, particularly females, pursuing mathematics and science do not need to be gender specific and should be implemented early in the academic careers of these individuals in order to spark interest and favorable attitudes toward the mathematics and science fields as well as to ensure adequate educational preparation. Later career decisions are built upon earlier ones.

Table 1
SAT scores earned in 7th/8th grade and at the end of high school by participants in the studies

	7th/8th-Grade SAT-V		**7th/8th-Grade SAT-M**	
	M	SD	M	SD
FEMALES				
Math/Science majors at age 18	456	85	501	70
(Effect Size)	-0.09		0.03	
Non-Math/Science majors at age 18	464	92	499	61
Persisters	463	90	509	76
(Effect Size)	0.08		0.18	
Nonpersisters	456	85	496	72
Persisters/Graduate school	469	67	510	60
(Effect Size)	-0.19		-0.10	
Persisters/No graduate school	486	115	518	94
Decreasers	467	97	509	64
(Effect Size)	0.38		-0.03	
Maintainers	499	73	507	63
(Effect Size)	0.51		0.05	
Increasers	455	100	504	62
MALES				
Math/Science majors at age 18	428	82	542	81
(Effect Size)	-0.04		0.23**	
Non-Math/Science majors at age 18	431	76	525	70
Persisters	431	78	552	82
(Effect Size)	0.12		0.33**	
Nonpersisters	421	92	526	75
Persisters/Graduate school	389	44	570	80
(Effect Size)	-0.18		0.47**	
Persisters/No graduate school	398	56	533	76
Decreasers	439	74	549	78
(Effect Size)	0.17		0.03	
Maintainers	452	80	551	75
(Effect Size)	-0.05		-0.08	
Increasers	456	88	557	79

High School SAT-V		High School SAT-M	
M	SD	M	SD
595	86	655	65
-0.12		0.10	
605	87	648	71
601	82	669	59
0.12		0.52**	
591	90	637	65
624	74	678	66
0.47*		0.18	
586	87	667	54
627	85	665	68
0.16		0.02	
640	79	666	63
0.41**		0.19	
609	74	654	62
589	87	701	67
-0.09		0.33**	
597	85	678	74
595	84	709	63
0.21*		0.43**	
577	88	680	72
612	85	727	55
0.42**		0.58**	
577	81	692	66
615	80	709	61
0.21*		0.00	
632	82	709	60
0.31*		0.08	
606	84	704	69

Table 1 continued.

Notes: 7th grade scores were adjusted upward to be comparable to 8th grade scores.
Cell sizes for 7th/8th grade SAT-V scores were much smaller than other cells, due to this test being administered to only the 1973 SMPY talent search participants
Probability levels of effect sizes determined by Cohen (1988).
*$p < .05$
**$p < .01$

Table 2
Characteristics of individuals who intended to major in math/science and those who intended to major in other areas at age 18

	Female Non-Math/Science Majors (N=260)				Female Math/Science Majors (N=410)	
Background	M	SD	Effect Size		M	SD
Father's educational level		1.9	2.27	*	4.2	1.8
Mother's educational level	3.4	1.4	-0.07		3.3	1.3
Father's occupational status	78.8	7.3	-0.16	*	77.6	7.9
Mean Effect Size			**0.68**			
Number of siblings	2.3	1.6	-0.13		2.5	1.6
Sibling position	2.2	1.3	0.00		2.2	1.4
Mean Effect Size			**-0.06**			
Values						
Theoretical	38.7	5.8	0.02		38.8	7.2
Economic	34.1	7.1	0.32		36.3	6.6
Aesthetic	40.8	7.7	-0.05		40.4	8.2
Social	46.7	6.6	-0.09		46.1	7.3
Political	39.2	6.5	-0.02		39.1	6.6
Religious	40.7	10.4	-0.12		39.5	10.0
Mean Effect Size			**0.01**			
Attitudes						
Math (7th grade)	3.8	0.8	0.13		3.9	0.8
Liking for math (H.S.)	4.0	1.1	0.40	**	4.4	0.9
Liking for biology (H.S.)	3.9	1.0	0.30	**	4.2	1.0
Liking for physics (H.S.)	3.1	1.2	0.25	**	3.4	1.2
Liking for chemistry (H.S.)	3.3	1.3	0.33	**	3.7	1.1
Consideration of math/science career	42%		0.68	**	75%	
Mean Effect Size			**0.39**	**		
H.S. Educational Experiences						
No. H.S. semesters of math	8.1	2.4	0.31	**	8.9	2.1
No. H.S. semesters of science	3.4	1.1	0.33	**	3.8	1.3
No. math/science achievement/AP tests	0.7	1.0	0.14		0.9	1.2
Completed a science project	13%		0.26	**	23%	
Competed a math contest	7%		0.20	*	13%	
Took H.S. calculus	36%		0.24	**	48%	
Took H.S. physics	48%		0.45	**	70%	
Completed a math/science college course	22%		-0.10		18%	
No. math/science AP courses	0.5	1.0	0.07		0.6	1.0
Mean Effect Size			**0.21**	**		

		Male Math/Science Majors (N=781)				Male Non-Math/Science Majors (N=329)	
Effect Size		M	SD	Effect Size		M	SD
0.06		4.3	1.8	-0.11		4.5	1.9
-0.08		3.2	1.3	-0.21	**	3.5	1.5
0.06		78.1	7.7	0.03		77.9	8.1
0.01				**-0.10**			
0.13	*	2.3	1.6	-0.06		2.2	1.6
0.07		2.1	1.3	0.00		2.1	1.3
0.10				**-0.03**			
1.14	**	47.1	7.4	0.15		46.0	7.0
0.84	**	42.0	6.9	0.12		41.2	6.9
-1.06	**	32.1	7.4	-0.15		33.2	7.4
-1.03	**	38.9	6.7	-0.23		40.3	5.7
0.86	**	44.6	6.2	0.13		43.8	6.2
-0.52	**	34.7	8.3	-0.08		35.4	9.4
0.04				**-0.01**			
0.27	**	4.1	0.7	0.13	*	4.0	0.8
						4.4	0.8
0.00		4.4	0.8	0.33	**	4.1	1.0
-0.38	**	3.8	1.1	0.09		3.7	1.1
0.52	**	4.0	1.1	0.36	**	3.6	1.1
0.19	**	3.9	1.0	0.45	**	3.4	1.2
-0.11			70%	0.47	**		47%
0.04				**0.34**	**		
0.26	**	9.5	2.5	0.24	**	8.9	2.5
0.22	**	4.1	1.4	0.31	**	3.7	1.2
0.56	**	1.7	1.7	0.39	**	1.1	1.4
-0.07			20%	0.05			18%
0.29	**		24%	0.17	**		17%
0.50	**		72%	0.19	**		63%
0.28	**		82%	0.28	**		70%
0.05			20%	0.05			18%
-0.35	**	1.0	1.4	0.13	*	0.8	1.3
0.19	**			**0.20**	**		

Table 2 continued.

Notes: Number of mathematics and science achievement and AP exams taken is a valuable assessment of involvement in mathematics and science because only the highly achieving and most motivated students take these exams and only the best schools offer a wide variety of high-level courses in these areas.
Effect size columns pertain to groups located to the immediate left and right.
Probability levels of effect sizes determined by Cohen (1988).
*p < .05
**p < .01

Table 3
Characteristics of individuals who all stated an intention to major in the math/sciences at age 18 and either completed such a major (persisters) or or did not (nonpersisters) by sex

	Females Nonpersisters (N=134)				Females Persisters (N=123)	
Background	M	SD	Effect Size		M	SD
Father's educational level	4.1	1.9	0.16		4.4	1.8
Mother's educational level	3.4	1.5	-0.07		3.3	1.4
Father's occupational status	76.8	8.2	0.12		77.7	7.4
Mean Effect Size			**0.07**			
Number of siblings	2.3	1.5	-0.20		2.6	1.5
Sibling position	2.2	1.3	-0.08		2.3	1.3
Mean Effect Size			**-0.14**			
Values						
Theoretical	36.9	7.3	0.37		39.5	6.8
Economic	37.5	6.1	-0.33		35.4	6.6
Aesthetic	40.8	8.1	-0.02		40.6	8.1
Social	46.2	8.7	-0.17		44.9	6.8
Political	37.2	7.2	0.47		40.2	5.6
Religious	41.5	11.0	-0.19		39.7	7.6
Mean Effect Size			**0.02**			
Attitudes						
Math (7th grade)	3.8	0.8	0.13		3.9	0.7
Liking for math (H.S.)	4.4	0.9	0.12		4.5	0.8
Liking for biology (H.S.)	4.0	1.1	0.09		4.1	1.1
Liking for physics (H.S.)	3.2	1.2	0.42	**	3.7	1.2
Liking for chemistry (H.S.)	3.6	1.2	0.35	**	4.0	1.1
Consideration of math/science career	63%		0.43	**	85%	
Mean Effect Size			**0.28**	**		
Liking for math (age 23)	3.7	0.8	0.14		3.8	0.6
Liking for science (age 23)	3.3	0.9	0.50	**	3.7	0.7
Mean Effect Size			**0.32**	**		
Locus of control (age 23)	2.1	0.3	-0.29	**	2.0	0.4
Self-esteem (age 23)	2.8	0.3	0.00		2.8	0.3
Mean Effect Size			**-0.14**			
H.S. Educational Experiences						
No. H.S. semesters of math	8.5	2.0	0.55	**	9.6	2.0
No. H.S. semesters of science	3.5	1.1	0.67	**	4.2	1.0
No. math/science achievement/AP tests	0.6	1.5	0.45	**	1.2	1.4
Completed a science project	19%		0.19		27%	
Competed in a math contest	13%		0.11		17%	
Took H.S. calculus	35%		0.51	**	60%	

Effect Size		Males Persisters (N=360) M	SD	Effect Size		Males Nonpersisters (N=150) M	SD
0.00		4.4	1.8	0.16		4.1	1.9
0.07		3.4	1.4	0.31	**	3.0	1.2
0.01		77.8	8.2	-0.14		78.9	7.0
0.03				**0.11**			
0.21	*	2.3	1.3	0.00		2.3	1.6
0.16		2.1	1.2	-0.08		2.0	1.2
0.19				**-0.04**			
0.97	**	46.5	7.6	0.00		46.5	7.6
0.94	**	42.0	7.4	0.37		39.4	6.5
-0.96	**	32.9	8.0	0.07		32.3	8.9
-0.95	**	38.4	6.9	-0.58	*	42.2	6.3
0.82	**	44.9	5.9	0.24		43.4	6.6
-0.68	**	34.3	8.3	-0.23		36.3	9.1
0.02				**-0.02**			
-0.31	**	3.7	0.6	-0.46	**	4.0	0.7
0.00		4.5	0.7	0.35	**	4.2	1.0
-0.43	**	3.6	1.2	-0.36	**	4.0	1.0
0.45	**	4.2	1.0	0.64	**	3.5	1.2
0.00		4.0	1.1	0.27	**	3.7	1.1
-0.51	**	75%		0.40	**	56%	
-0.10				**0.26**	**		
0.33	**	4.0	0.6	0.31	**	3.8	0.7
0.46	**	4.0	0.6	0.77	**	3.5	0.7
0.40	**			**0.54**	**		
0.00		2.0	0.5	-0.22	**	2.1	0.4
0.00		2.8	0.6	0.00		2.8	0.3
0.00				**-0.11**			
-0.10		9.4	2.2	0.13		9.1	2.3
0.10		4.3	1.1	0.52	**	3.7	1.2
0.45	**	1.9	1.7	0.42	**	1.2	1.6
-0.09		23%		0.21	*	15%	
0.29	**	29%		0.34	**	15%	
0.42	**	79%		0.46	**	58%	

Took H.S. physics		62%	0.31	**		76%
Completed a math/science college course		25%	-0.17			18%
No. math/science AP courses	0.4	0.8	0.31	**	0.7	1.1
Mean Effect Size			**0.32**	**		
Rank of college attended (median)		367				198
<u>Lifestyle Expectations</u>						
Importance of education/work	0.8	0.2	-0.50	**	0.7	0.2
Importance of family/friends	0.7	0.2	0.00		0.7	0.2
Importance of community involvement	0.3	0.3	0.00		0.3	0.3
Importance of changing location	0.1	0.3	0.00		0.1	0.2
Importance of getting married		81%	0.16			87%
Importance of having children		72%	0.09			76%
Mean Effect Size			**-0.04**			
<u>Employment Expectations</u>						
Importance of full-time career		43%	0.14			50%
Importance of parttime career		43%	0.10			38%
Mean Effect Size			**0.12**			
<u>Encouragement</u>						
To study math/science from parents	2.8	0.7	0.43	**	3.1	0.7
To study math/science from others	2.6	0.6	0.33	*	2.8	0.6
To attend college from parents	3.6	0.6	0.36	**	3.8	0.5
To attend college from others	3.5	0.6	0.00		3.5	0.7
To pursue current goals from parents	3.0	0.9	0.24		3.2	0.8
To pursue current goals from others	2.8	0.8	0.27	**	3.0	0.7
Person influenced career decisions		49%	0.04			51%
Mean Effect Size			**0.24**			

Notes: Effect size columns pertain to groups located to the immediate left and right.
Probability levels of effect sizes determined by Cohen (1988).
*p < .05
**p < .01

0.29	**		87%		0.38	**		72%	
0.10			22%		0.10			18%	
0.24	*	1.1		2.3	0.17		0.8		1.3
0.19					**0.30**	**			
			24					201	
0.00		0.7		0.2	0.00		0.7		0.2
0.00		0.7		0.2	0.00		0.7		0.2
0.00		0.3		0.3	-0.33	**	0.4		0.3
0.00		0.1		0.2	0.00		0.1		0.2
0.24	*		78%		0.18			70%	
0.11			71%		0.13			65%	
0.06					**-0.00**				
0.69	**		82%		0.15			76%	
0.98	**		3%		0.00			3%	
0.84	**				**0.08**				
0.00		3.1		0.7	0.43	**	2.8		0.7
0.00		2.8		0.6	0.55	**	2.5		0.5
0.00		3.8		0.5	0.33	**	3.6		0.7
-0.14		3.4		0.7	0.13		3.3		0.8
-0.25	*	3.0		0.8	0.22	*	2.8		1.0
-0.29	**	2.8		0.7	0.13		2.7		0.8
-0.28	**		37%		0.04			39%	
-0.14					**0.26**	**			

Table 4
Characteristics of individuals who changed into math/science majors after age 18 and completed such majors by sex

	Effect Size (with male persisters)		Males (N=131) M	SD	Effect Size	
Background						
Father's educational level	-0.11		4.6	1.7	0.06	
Mother's educational level	0.15		3.2	1.2	-0.08	
Father's occupational status	-0.09		78.5	8.0	0.19	
Mean Effect Size	**-0.02**				0.06	
Number of siblings	-0.06		2.4	1.8	-0.18	
Sibling position	0.08		2.0	1.3	-0.31	
Mean Effect Size	**0.01**				**-0.24**	
Attitudes						
Math (7th grade)	-0.62	**	4.1	0.7	0.29	
Liking for math (H.S.)	0.00		4.5	0.8	0.25	
Liking for biology (H.S.)	-0.18		3.8	1.0	-0.29	
Liking for physics (H.S.)	0.00		4.2	1.0	0.73	**
Liking for chemistry (H.S.)	-0.10		4.1	0.9	0.00	
Consideration of math/science career	-0.10		79%		0.03	
Mean Effect Size	**-0.08**				**0.14**	
Liking for math (age 23)	0.00		4.0	0.6	0.31	
Liking for science (age 23)	0.00		4.0	0.6	0.46	*
Mean Effect Size	0.00				**0.38**	*
Locus of control (age 23)	0.00		2.0	0.4	-0.25	
Self-esteem (age 23)	0.20		2.7	0.4	-0.29	
Mean Effect Size	0.10				**-0.27**	
H.S. Educational Experiences						
No. H.S. semesters of math	-0.23	*	9.9	2.1	0.20	
No. H.S. semesters of science	0.23	*	4.0	1.5	0.00	
No. math/science achievement/AP tests	0.00		1.9	1.7	0.52	**
Completed a science project	0.18		16%		-0.20	
Competed in a math contest	0.02		28%		0.19	
Took H.S. calculus	0.16		72%		0.58	**
Took H.S. physics	0.16		81%		0.12	
Completed a math/science college course	-0.07		25%		0.15	
No. math/science AP courses	-0.10		1.3	1.6	0.30	
Mean Effect Size	0.08				**0.14**	
Rank of college attended (median)			201			
Lifestyle Expectations						
Importance of education/work	-0.50	**	0.8	0.2	0.00	
Importance of family/friends	0.00		0.7	0.2	0.00	
Importance of community involvement	0.00		0.3	0.3	0.00	

Females (N=42)			
M	SD	Effect Size (with female persisters)	
4.5	1.8	-0.06	
3.3	1.4	0.00	
77.0	7.4	0.09	
		0.01	
2.7	1.5	-0.07	
2.4	1.3	-0.08	
		-0.07	
3.9	0.7	0.00	
4.3	0.8	0.25	
4.1	1.1	0.00	
3.4	1.2	0.25	
4.1	1.1	-0.09	
78%		0.18	
		0.12	
3.8	0.7	0.00	
3.7	0.7	0.00	
		0.00	
2.1	0.4	-0.25	
2.8	0.3	0.00	
		-0.13	
9.5	2.0	0.05	
4.0	1.0	0.20	
1.1	1.4	0.07	
24%		0.07	
20%		-0.08	
44%		0.12	
76%		0.00	
19%		0.03	
0.9	1.1	-0.18	
		0.04	
198			
0.8	0.2	-0.50	**
0.7	0.2	0.00	
0.3	0.3	0.00	

Importance of changing location	0.10	0.1	0.2	-0.10	
Importance of getting married	-0.10	86%		-0.03	
Importance of having children	-0.07	74%		-0.14	
Mean Effect Size	-0.10			**-0.04**	
<u>Employment Expectations</u>					
Importance of full-time career	-0.08	85%		0.88	**
Importance of parttime career	0.00	3%		1.00	**
Mean Effect Size	-0.04			**0.94**	**
<u>Encouragement</u>					
To study math/science from parents	0.14	3.0	0.7	-0.05	
To study math/science from others	-0.17	2.9	0.6	0.18	
To attend college from parents	0.00	3.8	0.4	-0.05	
To attend college from others	0.00	3.4	0.7	0.00	
To pursue current goals from parents	0.00	3.0	1.0	-0.10	
To pursue current goals from others	-0.14	2.9	0.7	-0.05	
Person influenced career decisions	-0.14	44%		-0.22	
Mean Effect Size	**-0.04**			**-0.04**	

Note: Effect size columns pertain to groups located to the immediate left and right.
Values are not reported since such a small number of these individuals completed the Study of Values.
Probability levels of effect sizes determined by Cohen (1988).
*p < .05
**p < .01

0.1	0.2	0.00
	93%	-0.13
	80%	-0.10
		-0.12
	56%	-0.12
	41%	0.06
		-0.03
3.1	3.1	0.00
2.6	2.8	0.12
3.9	3.8	-0.05
3.4	3.5	0.05
3.2	3.2	0.00
3.0	3.0	0.00
	55%	-0.10
		0.00

Table 5
Characteristics of persisters (those completing a math/science major) who pursued graduate study in math/science and those who did not by sex

	Female Persisters No Graduate School (N=51)				**Female Persisters Graduate School (N=47)**	
Background	M	SD	Effect Size		M	SD
Father's educational level	4.5	1.9	-0.12		4.3	1.5
Mother's educational level	3.2	1.3	0.22		3.5	1.4
Father's occupational status	77.8	8.2	-0.07		77.3	6.9
Mean Effect Size			**0.01**			
Number of siblings	2.6	1.6	0.13		2.4	1.4
Sibling position	2.2	1.2	-0.15		2.4	1.5
Mean Effect Size			**-0.01**			
Values						
Theoretical	39.6	7.1	-0.07		39.1	8.1
Economic	32.7	7.5	0.45		35.6	5.4
Aesthetic	38.0	6.2	0.27		40.1	9.3
Social	48.3	5.7	-0.39		45.6	8.1
Political	40.0	4.0	-0.09		39.5	7.0
Religious	41.4	6.7	-0.17		40.0	9.6
Mean Effect Size			**0.00**			
Attitudes						
Math (7th grade)	4.0	0.6	-0.29		3.8	0.8
Liking for math (H.S.)	4.5	0.8	0.00		4.5	1.0
Liking for biology (H.S.)	3.8	1.4	0.67	**	4.5	0.7
Liking for physics (H.S.)	3.6	1.2	0.35		4.0	1.1
Liking for chemistry (H.S.)	3.9	1.2	0.09		4.0	1.1
Consideration of math/science career	80%		0.25		89%	
Mean Effect Size			**0.27**			
Liking for math (age 23)	3.8	0.7	0.00		3.8	0.6
Liking for science (age 23)	3.6	0.8	0.62	**	4.0	0.5
Mean Effect Size			**0.31**			
Locus of control (age 23)	2.1	0.4	-0.44	*	1.9	0.5
Self-esteem (age 23)	2.8	0.4	0.29		2.9	0.3
Mean Effect Size			**-0.08**			
H.S. Educational Experiences						
No. H.S. semesters of math	9.6	1.5	0.18		9.9	1.9
No. H.S. semesters of science	4.0	0.8	0.53	*	4.5	1.1
No. math/science achievement/AP te	0.9	1.1	0.52	*	1.6	1.6
Completed a one science project	29%		-0.07		26%	
Competed in a math contest	16%		0.03		17%	
Took H.S. calculus	51%		0.44	*	72%	
Took H.S. physics	84%		-0.33		70%	

	Male Persisters Graduate School (N=159)			Male Persisters No Graduate School (N=124)	
Effect Size	M	SD	Effect Size	M	SD
0.25	4.7	1.7	0.47 **	3.9	1.7
0.00	3.5	1.3	0.15	3.3	1.4
0.58 **	81.0	5.9	0.79 **	74.8	9.8
0.28			**0.47** **		
0.00	2.4	1.5	-0.06	2.3	1.7
0.30	2.0	1.2	0.08	2.1	1.3
0.15			**0.01**		
1.03 *	47.1	7.4	0.11	46.2	8.3
0.92 *	41.4	7.2	-0.15	42.5	7.7
-0.90 *	32.1	8.4	-0.16	33.4	7.5
-0.99 *	38.5	6.3	-0.01	38.6	7.9
0.93 *	45.5	5.9	0.13	44.7	6.6
-0.61	34.4	8.7	0.13	33.3	8.7
0.06			**0.01**		
0.40 *	4.1	0.7	0.00	4.1	0.7
0.00	4.5	0.8	-0.29 *	4.7	0.6
-0.74 **	3.8	1.2	0.33 *	3.4	1.2
0.19	4.2	1.0	0.00	4.2	0.9
0.19	4.2	1.0	0.29 *	3.9	1.1
-0.28		79%	-0.02		80%
-0.13			**0.06**		
0.17	3.9	0.6	-0.18	4.0	0.5
0.40 *	4.2	0.5	0.50 **	3.9	0.7
0.28			**0.16**		
0.44 **	2.1	0.4	0.44 **	1.9	0.5
-0.22	2.8	0.6	0.20	2.7	0.4
0.11			**0.32** *		
0.00	9.9	2.6	0.19	9.4	2.7
-0.17	4.3	1.2	0.23	4.0	1.4
0.50 **	2.4	1.6	0.55 **	1.5	1.7
-0.09		22%	-0.09		26%
0.42 *		35%	0.34 **		20%
0.24		82%	0.12		77%
0.48 **		89%	0.20		82%

Completed a math/science college course		18%	0.03			17%
No. math/science AP courses	0.5	1.0	0.35		0.9	1.3
Mean Effect Size			**0.19**			
College Educational Experiences						
Overall colliege gpa	3.29	0.4	0.27		3.40	0.4
Math gpa	3.29	0.6	0.56	**	3.54	0.3
Science gpa	3.16	0.6	0.66	**	3.49	0.4
Overall rank in college class	1.2	0.9	0.44	*	0.8	0.9
No. of math courses	6.0	6.4	-0.10		5.4	5.6
No. of science courses	6.6	6.6	0.53	**	10.9	9.6
No. of math credits earned	24.6	20.9	-0.05		23.6	17.3
No. of science credits earned	25.7	20.5	0.71	**	42.8	27.6
Mean Effect Size			**0.38**	*		
Rank of college attended (median)		176				135
Lifestyle Expectations						
Importance of education/work	0.7	0.2	0.00		0.7	0.1
Importance of family/friends	0.7	0.2	0.00		0.7	0.2
Importance of community involveme	0.3	0.2	0.00		0.3	0.3
Importance of changing location	0.1	0.2	0.00		0.1	0.2
Importance of getting married		92%	0.17			96%
Importance of having children		80%	0.13			85%
Mean Effect Size			**0.05**			
Employment Expectations						
Importance of full-time career		45%	0.38			64%
Importance of parttime career		47%	0.27			34%
Mean Effect Size			**0.33**			
Encouragement						
To study math/science from parents	3.1	0.7	0.00		3.1	0.7
To study math/science from others	2.8	0.6	0.00		2.8	0.6
To attend college from parents	3.8	0.5	0.25		3.9	0.3
To attend college from others	3.5	0.7	0.00		3.5	0.7
To pursue current goals from parent	3.1	0.8	0.53	*	3.5	0.7
To pursue current goals from others	3.0	0.7	0.29		3.2	0.7
Person influenced career decisions		42%	0.37			58%
Mean Effect Size			**0.21**			

Note: Effect size columns pertain to groups located to the immediate left and right.
Probability levels of effect sizes determined by Cohen (1988).

*p < .05

**p < .01

0.27			28%	0.32	*		15%
0.36	*	1.4	1.5	0.44	**	0.8	1.2
0.22				**0.26**	*		
0.40		3.56	0.4	0.89	**	3.16	0.5
0.20	*	3.61	0.4	0.80	**	3.21	0.6
0.00		3.49	0.4	1.18	**	2.96	0.5
0.24		0.6	0.8	0.82	**	1.3	0.9
0.18		6.4	5.6	-0.18		7.4	5.6
0.02		11.1	9.3	0.49	**	6.8	8.3
0.14		26.2	19.0	-0.21		30.0	17.5
0.03		43.7	28.0	0.62	**	27.0	25.6
0.15				**0.55**	**		
			91				176
0.00		0.7	0.2	0.00		0.7	0.2
0.00		0.7	0.2	0.00		0.7	0.2
0.33	*	0.4	0.3	0.67	**	0.2	0.3
0.00		0.1	0.2	0.00		0.1	0.2
-0.34	*		87%	-0.03			88%
-0.11			81%	0.08			78%
-0.02				**0.12**			
0.79	**		94%	0.15			90%
0.96	**		2%	0.21			6%
0.88	**			**0.18**			
0.00		3.1	0.7	0.13		3.0	0.8
0.00		2.8	0.6	0.00		2.8	0.6
-0.29		3.8	0.4	0.20		3.7	0.6
-0.14		3.4	0.7	0.00		3.4	0.7
-0.53	**	3.1	0.8	0.13		3.0	0.8
-0.40	*	2.9	0.8	0.27	*	2.7	0.7
-0.37	*		42%	0.25			30%
-0.25				**0.14**			

Table 6
Characteristics of math/science persisters (those completing a math/science major) who majored in areas other than engineering, computer science, or mathematics by sex and by graduate school

	Female Persisters No Graduate School (N=20)				Female Persisters Graduate School (N=30)	
Background	M	SD	Effect Size		M	SD
Father's educational level	4.6	1.6	0.06		4.7	1.5
Mother's educational level	3.2	1.2	0.31		3.6	1.4
Father's occupational status	77.8	8.0	0.14		78.7	5.2
Mean Effect Size			**0.17**			
Number of siblings	2.2	1.2	-0.28		2.6	1.7
Sibling position	2.3	1.1	0.00		2.3	1.5
Mean Effect Size			**-0.14**			
Attitudes						
Math (7th grade)	4.1	0.6	-0.33		3.9	0.6
Liking for math (H.S.)	4.2	1.0	0.00		4.2	1.1
Liking for biology (H.S.)	4.6	0.8	0.50		4.9	0.4
Liking for physics (H.S.)	3.4	1.2	0.26		3.7	1.1
Liking for chemistry (H.S.)	3.8	1.4	0.29		4.1	0.7
Consideration of math/science career	85%		0.03		86%	
Mean Effect Size			**0.22**			
Liking for math (age 23)	3.7	0.7	-0.15		3.6	0.6
Liking for science (age 23)	4.0	0.6	0.40		4.2	0.4
Mean Effect Size			**0.12**			
Locus of control (age 23)	2.0	0.4	-0.22		1.9	0.5
Self-esteem (age 23)	2.7	0.4	0.57		2.9	0.3
Mean Effect Size			**0.17**			
H.S. Educational Experiences						
No. H.S. semesters of math	9.4	1.5	-0.19		9.1	1.7
No. H.S. semesters of science	4.1	0.9	0.36		4.5	1.3
No. math/science achievement/AP tests	1.3	1.2	0.07		1.4	1.5
Completed a science project	30%		-0.16		23%	
Competed in a math contest	20%		-0.28		10%	
Took H.S. calculus	50%		0.26		63%	
Took H.S. physics	85%		-0.57	*	60%	
Completed a math/science college course	10%		0.18		16%	
No. math/science AP courses	0.9	1.4	0.07		1.0	1.4
Mean Effect Size			**-0.03**			
College Educational Experiences						
No. of awards earned	1.0	0.8	0.74	*	1.8	1.5
Overall colllege gpa	3.43	0.3	0.14		3.48	0.4
Math gpa	3.49	0.5	-0.18		3.41	0.4
Science gpa	3.22	0.6	0.52		3.48	0.4

Effect Size		Male Persisters Graduate School (N=85) M	SD	Effect Size		Male Persisters No Graduate School (N=19) M	SD
0.06		4.8	1.8	0.62	*	3.6	2.1
-0.07		3.5	1.3	0.24		3.2	1.2
0.42	*	81.2	6.7	1.02	**	71.8	11.7
0.14				**0.63**	*		
0.26		2.2	1.4	0.00		2.2	1.2
0.23		2.0	1.1	0.20		2.2	0.9
0.24				**0.10**			
0.33		4.1	0.6	0.17		4.0	0.6
0.20		4.4	0.9	0.00		4.4	0.8
-0.86	**	4.3	1.0	0.00		4.3	0.9
0.36	*	4.1	1.1	0.26		3.8	1.2
0.27		4.3	0.8	0.25		4.1	0.8
0.16		91%		-0.21		84%	
0.03				**0.06**			
0.73	**	4.0	0.5	0.33		3.8	0.7
0.25		4.3	0.4	0.80	**	3.9	0.6
0.49	*		**0.4**	**0.57**	*		
0.25		2.0	0.3	-0.33		2.1	0.3
-0.33		2.8	0.3	0.57	*	2.6	0.4
-0.04				**0.12**			
0.30		9.7	2.3	0.28		9.1	2.0
0.00		4.5	1.2	0.15		4.3	1.4
0.73	**	2.6	1.8	0.85	**	1.2	1.5
0.09		27%		0.02		26%	
0.60	**	34%		0.79	**	5%	
0.49	*	84%		0.49		63%	
0.69	**	89%		0.15		84%	
-0.03		15%		0.34		5%	
0.40	*	1.6	1.6	0.69	**	0.7	1.0
0.36	*			**0.42**			
-0.08		1.7	1.1	0.61	*	1.0	1.2
0.12		3.53	0.4	0.93	**	3.11	0.5
0.42	*	3.60	0.5	0.48		3.31	0.7
-0.02		3.47	0.4	0.98	**	2.98	0.6

Overall rank in college class	1.8		1.9	-0.05		1.9		2.1
No. of math courses	2.8		2.7	0.04		2.9		3.0
No. of science courses	9.5		8.2	0.33		12.5		10.1
No. of math credits earned	9.3		6.2	0.60	*	14.4		10.8
No. of science credits earned	34.1		24.7	0.87	**	55.9		25.7
Mean Effect Size				**0.33**				
Rank of college attended (median)			114					46
Lifestyle Expectations								
Importance of education/work	0.7		0.2	0.67	*	0.8		0.1
Importance of family/friends	0.7		0.1	0.00		0.7		0.2
Importance of community involvement	0.3		0.3	0.00		0.3		0.3
Importance of changing location	0.1		0.2	0.00		0.1		0.2
Importance of getting married		90%		0.11			93%	
Importance of having children		80%		0.08			83%	
Mean Effect Size				**0.14**				
Employment Expectations								
Importance of full-time career		40%		0.68	*		73%	
Importance of parttime career		50%		0.57	*		23%	
Mean Effect Size				**0.63**	*			
Encouragement								
To study math/science from parents	3.0		0.7	0.14		3.1		0.7
To study math/science from others	2.7		0.7	0.15		2.8		0.6
To attend college from parents	3.8		0.4	0.29		3.9		0.3
To attend college from others	3.4		0.7	0.00		3.4		0.6
To pursue current goals from parents	2.8		0.8	0.80	**	3.4		0.7
To pursue current goals from others	2.8		0.8	0.38		3.1		0.8
Person influenced career decisions		35%		0.31			50%	
Mean Effect Size				**0.30**				

Notes: Effect size columns pertain to groups located to the immediate left and right.
Probability levels of effect sizes determined by Cohen (1988).
*p < .05
**p < .01
Values are not reported since a small number of these individuals completed the Study of Values.

0.37	*	1.2	1.7	0.57	*	2.2	1.8
0.37	*	4.1	3.5	-0.06		4.3	3.7
0.27		15.2	9.9	0.43		11.3	8.1
0.17		16.2	10.9	0.06		15.5	11.4
0.16		60	25.9	0.70	**	41.4	26.9
0.20				**0.52**	***/fsr**		
			29				172
0.00		0.8	0.2	0.00		0.8	0.1
0.00		0.7	0.2	0.00		0.7	0.2
0.33		0.4	0.3	0.33		0.3	0.3
0.40	*	0.2	0.3	0.33		0.1	0.3
-0.17		88%		-0.26		95%	
-0.10		79%		-0.13		84%	
0.08				**0.05**			
0.64	**	95%		0.23		89%	
0.80	**	1%		0.48		11%	
0.72	**			**0.36**			
0.00		3.1	0.7	0.43		2.8	0.7
0.00		2.8	0.6	-0.31		3.0	0.7
-0.25		3.8	0.5	0.50		3.5	0.7
0.00		3.4	0.8	0.37		3.1	0.8
-0.37		3.1	0.9	0.38		2.8	0.7
-0.13	*	3.0	0.7	0.43		2.7	0.7
-0.10		45%		0.16		37%	
-0.12				**0.28**			

Table 7
Characteristics of females who maintained, lowered, or raised educational aspirations to earn a doctorate over the college years

	Female Decreasers (Non-engineering/computer science/ math majors) (N=169)				Female Decreasers (N=184)	
	M	SD	Effect Size (with maintainers)		M	SD
Background						
Father's educational level	4.7	1.9	0.22		4.7	1.9
Mother's educational level	3.6	1.5	0.07		3.6	1.5
Father's occupational status	78.6	8.6	0.20		78.7	8.1
Mean Effect Size			**0.16**			
Number of siblings	2.2	1.2	0.00		2.3	1.3
Sibling position	2.1	1.3	-0.14		2.1	1.3
Mean Effect Size			**-0.07**			
Values						
Theoretical	43.1	6.2	-0.38		43.3	6.3
Economic	35.6	7.5	0.06		35.8	7.7
Aesthetic	39.1	7.7	0.14		38.9	7.6
Social	45.6	4.9	0.16		45.4	5.5
Political	41.5	5.9	-0.39		41.7	5.6
Religious	34.8	9.9	0.30		35.0	9.5
Mean Effect Size			**-0.04**			
Attitudes						
Liking/importance for math (7th grade)	3.8	0.7	0.40	**	4.1	0.8
Liking for math (H.S.)	4.0	0.9	0.00		4.1	1.0
Liking for biology (H.S.)	4.4	0.9	-0.11		4.3	1.0
Liking for physics (H.S.)	3.1	1.3	0.17		3.5	1.1
Liking for chemistry (H.S.)	3.6	1.2	0.35	*	3.7	1.2
Consideration of math/science career	64%		0.19		69%	
Mean Effect Size			**0.12**			
Liking for math (age 23)	3.6	0.8	-0.13		3.6	0.8
Liking for science (age 23)	3.5	0.9	0.22		3.4	0.9
Mean Effect Size			**0.04**			
Locus of control (age 23)	2.0	0.4	0.00		2.0	0.4
Self-esteem (age 23)	2.7	0.4	0.57	**	2.8	0.4
Mean Effect Size			**0.29**	*		
H.S. Educational Experiences						
No. H.S. semesters of math	8.9	1.6	-0.13		8.7	2.3
No. H.S. semesters of science	3.9	1.1	0.09		4.0	1.3
No. math/science achievement/AP tests	1.0	1.2	0.31	*	1.1	1.3
Completed at least one science project	9%		0.13		20%	
Competed in at least one math contest	11%		-0.15		10%	
Took H.S. calculus	47%		0.20		50%	

	Female Maintainers				Female Increasers		
		(N=67)				(N=49)	
Effect Size		M	SD	Effect Size		M	SD
0.22		5.1	1.7	0.59	**	4.1	1.7
0.07		3.7	1.5	0.15		3.5	1.2
0.19		80.2	7.3	0.40	*	76.8	9.7
0.16				**0.38**	*		
0.07		2.2	1.6	0.06		2.3	1.6
-0.14		2.3	1.5	-0.21		2.0	1.3
-0.04				**-0.08**			
-0.41		40.9	5.5	0.33		39.0	5.9
0.03		36.0	4.9	0.27		34.5	6.4
0.17		40.1	6.5	0.10		39.4	8.1
0.18		46.5	6.5	0.23		44.9	7.2
-0.43		39.2	6.0	-0.32		41.0	5.4
0.29		37.7	9.4	-0.41		41.2	7.8
-0.03				**0.03**			
-0.13		4.0	0.7	-0.15		4.1	0.6
-0.09		4.0	1.2	0.00		4.0	0.9
0.00		4.3	1.0	0.10		4.2	1.0
-0.18		3.3	1.1	0.09		3.2	1.1
0.26		4.0	1.1	0.48	*	3.5	1.0
0.09			73%	0.38	*		55%
0.02				**0.21**			
-0.13		3.5	0.7	-0.29		3.7	0.7
0.33	*	3.7	0.9	0.25		3.5	0.7
0.10				**-0.02**			
0.00		2.0	0.3	0.27		1.9	0.4
0.29	*	2.9	0.3	0.29		2.8	0.4
0.14				**0.28**			
-0.04		8.6	2.9	0.08		8.4	2.2
0.00		4.0	1.2	0.67	**	3.1	1.5
0.22		1.4	1.4	0.61	**	0.7	0.9
-0.19			13%	-0.24			22%
0.18			16%	-0.15			22%
0.14			57%	0.49	**		33%

Took H.S. physics		55%	0.18			65%
Completed at least one math/science college course		15%	0.11			23%
No. math/science AP courses	0.7	1.3	0.23		0.7	1.2
Mean Effect Size			**0.11**			
<u>College Educational Experiences</u>						
No. of awards earned	1.2	1.1	0.46	**	0.5	0.9
Overall colllege gpa	3.41	0.5	0.31	*	3.40	0.4
Math gpa	3.34	0.4	0.55	**	3.33	0.5
Science gpa	3.20	1.9	0.28		3.16	0.5
Overall rank in college class	1.9	2.6	0.82	**	0.9	0.8
No. of math courses	2.9	6.5	-0.06		4.1	4.7
No. of science courses	5.7	6.5	0.30	*	5.5	6.6
No. of math credits earned	11.3	18.7	-0.03		15.9	20.6
No. of science credits earned	19.8	22.3	0.42	**	19.2	20.7
Mean Effect Size			**0.34**	*		
Rank of college attended (median)		279				201
<u>Lifestyle Expectations</u>						
Importance of education/work	0.7	0.2	0.50	**	0.7	0.2
Importance of family/friends	0.7	0.2	0.00		0.7	0.2
Importance of community involvement	0.4	0.3	0.00		0.4	0.3
Importance of changing location	0.1	0.2	0.40	**	0.1	0.2
Importance of getting married		78%	0.15			34%
Importance of having children		67%	0.25			29%
Mean Effect Size			**0.22**			
<u>Employment Expectations</u>						
Importance of full-time career		45%	0.30	*		18%
Importance of parttime career		40%	0.28	*		18%
Mean Effect Size			**0.29**	*		
<u>Encouragement</u>						
To study math/science from parents	3.0	0.8	0.00		3.0	0.7
To study math/science from others	2.5	0.8	0.14		2.5	0.8
To attend college from parents	3.8	0.5	0.25		3.8	0.8
To attend college from others	3.7	0.8	0.00		3.7	0.7
To pursue current goals from parents	3.0	0.9	0.80	**	2.9	0.8
To pursue current goals from others	2.8	1.0	0.63	**	2.9	1.0
Person influenced career decisions		42%	0.22			55%
Mean Effect Size			**0.29**	*		

Notes: Effect size columns pertain to groups located to the immediate left and right.
Probability levels of effect sizes determined by Cohen (1988).

*$p < .05$

**$p < .01$

-0.02			64%	0.26			51%
-0.10			19%	0.14			14%
0.24		1.0	1.3	0.33		0.6	1.1
0.05				**0.24**			
1.08	**	1.8	1.5	0.37	*	1.3	1.2
0.37	*	3.55	0.4	0.25		3.45	0.4
0.51	**	3.56	0.4	0.00		3.57	0.5
0.80	**	3.52	0.4	0.20		3.44	0.4
0.50	**	0.5	0.8	0.35		0.8	0.9
-0.40	**	2.6	2.8	-0.16		3.0	2.3
0.32	*	7.9	8.2	0.17		6.5	8.2
-0.31	*	10.9	12.0	0.03		10.6	8.8
0.45	**	30.0	26.8	0.30		22.0	27.3
0.41	*			**0.18**			
			72				201
0.50	**	0.8	0.2	0.50	**	0.7	0.2
0.00		0.7	0.2	0.00		0.7	0.2
0.00		0.4	0.2	-0.40	*	0.5	0.3
0.40	**	0.2	0.3	0.00		0.2	0.3
1.10	**		84%	0.05			82%
1.00	**		78%	0.05			76%
0.50	**			**0.03**			
0.90	**		60%	-0.06			63%
-0.22			27%	-0.07			24%
0.34	*			**-0.07**			
0.00		3.0	0.8	0.27		2.8	0.7
0.14		2.6	0.6	0.00		2.6	0.7
0.18		3.9	0.3	0.60	**	3.6	0.7
0.00		3.7	0.5	0.55	**	3.4	0.6
1.00	**	3.6	0.6	0.67	**	3.1	0.9
0.50	**	3.3	0.6	0.15		3.2	0.7
-0.04			53%	-0.14			60%
0.25				**0.30**			

Table 8
Characteristics of males who maintained, lowered, or raised educational aspirations to earn a doctorate over the college years

	Male Decreasers (Non-engineering/computer science/ math majors) (N=237)				Male Decreasers (N=301)	
	M	SD	Effect Size (with maintainers)		M	SD
Background						
Father's educational level	4.7	1.9	0.32	**	4.9	1.9
Mother's educational level	3.4	1.4	0.29	**	3.6	1.4
Father's occupational status	79.0	8.0	0.30	**	79.0	8.0
Mean Effect Size			**0.30**	**		
Number of siblings	2.3	1.6	0.06		2.1	1.6
Sibling position	1.8	1.2	-0.16		1.9	1.2
Mean Effect Size			**-0.05**			
Values						
Theoretical	46.4	8.4	0.01		46.5	8.3
Economic	42.9	6.9	-0.33		42.7	6.8
Aesthetic	32.9	7.1	0.00		32.9	7.2
Social	38.3	6.5	0.21		38.4	6.5
Political	44.1	6.1	0.10		43.9	6.3
Religious	35.4	8.5	-0.04		35.5	8.3
Mean Effect Size			**-0.01**			
Attitudes						
Math (7th grade)	4.1	0.7	-0.14		4.1	0.8
Liking for math (H.S.)	4.2	0.9	0.11		4.3	0.9
Liking for biology (H.S.)	4.0	1.1	0.10		3.9	1.1
Liking for physics (H.S.)	3.8	1.1	0.00		3.9	1.1
Liking for chemistry (H.S.)	3.9	1.1	0.10		3.9	1.1
Consideration of math/science career	61%		0.35	**	70%	
Mean Effect Size			**0.13**			
Liking for math (age 23)	3.8	0.7	-0.14		3.9	0.7
Liking for science (age 23)	3.6	0.7	0.57	**	3.8	0.7
Mean Effect Size			**0.21**	*		
Locus of control (age 23)	2.1	0.5	-0.22	*	2.0	0.5
Self-esteem (age 23)	2.8	0.4	0.00		2.7	0.4
Mean Effect Size			**-0.11**			
H.S. Educational Experiences						
No. H.S. semesters of math	9.2	2.5	0.12		9.5	2.5
No. H.S. semesters of science	4.1	1.4	0.23	*	4.3	1.4
No. math/science achievement/AP tes	1.4	1.7	0.47	**	1.8	1.7
Completed a science project	17%		0.13		15%	
Competed in a one math contest	10%		0.49	**	22%	
Took H.S. calculus	64%		0.34	**	74%	

Male Maintainers				Male Increasers			
		(N=173)				(N=109)	
Effect Size		M	SD	Effect Size		M	SD
0.22	*	5.3	1.8	0.74	**	4.0	1.7
0.14		3.8	1.4	0.46	**	3.2	1.2
0.30	**	81.2	6.8	0.57	**	76.5	9.7
0.22	*			**0.59**	**		
-0.06		2.2	1.5	0.19		2.5	1.6
-0.08		2.0	1.3	0.08		2.1	1.3
-0.07				**0.14**			
0.00		46.5	6.0	-0.08		47.0	6.6
-0.31		40.3	8.9	-0.16		41.5	5.9
0.00		32.9	8.3	-0.13		34.0	8.7
0.19		39.6	5.9	0.08		39.1	7.2
0.13		44.8	7.3	0.09		44.2	5.6
-0.06		35.0	9.5	0.07		34.3	10.5
-0.01				**-0.02**			
-0.13		4.0	0.7	-0.15		4.1	0.6
0.00		4.3	1.0	-0.11		4.4	0.9
0.19		4.1	1.0	0.10		4.0	1.0
-0.09		3.8	1.2	-0.17		4.0	1.1
0.10		4.0	1.0	0.10		3.9	1.0
0.16		77%		0.43	**	57%	
0.07				**0.07**			
-0.29	**	3.7	0.7	-0.14		3.8	0.7
0.29	**	4.0	0.7	0.29	*	3.8	0.7
0.00				**0.07**			
0.00		2.0	0.4	0.00		2.0	0.4
0.25	*	2.8	0.4	0.00		2.8	0.4
0.12				**0.00**			
0.00		9.5	2.7	-0.04		9.6	2.3
0.08		4.4	1.2	0.69	**	3.5	1.4
0.24	*	2.2	1.7	0.50	**	1.4	1.5
0.18		22%		0.13		17%	
0.16		29%		0.02		28%	
0.12		79%		0.25	*	68%	

Took H.S. physics		76%	0.20	*		81%
Completed a math/science college course		17%	0.17			27%
No. math/science AP courses	0.8	1.5	0.50	**	1.1	1.5
Mean Effect Size			**0.29**	**		
<u>College Education Experiences</u>						
No. of awards earned	1.1	1.0	0.45	**	0.5	1.0
Overall college gpa	3.27	0.5	0.58	**	3.22	0.5
Math gpa	3.29	0.6	0.40	**	3.29	0.6
Science gpa	3.21	0.5	0.44	**	3.19	0.5
Overall rank in college class	2.1	0.9	1.65	**	1.2	0.9
No. of math courses	3.6	4.9	0.21	*	5.4	4.9
No. of science courses	6.5	8.5	0.37	**	6.8	8.5
No. of math credits earned	13.2	20.4	0.12		23.0	20.4
No. of science credits earned	25.3	27.5	0.39	**	25.0	27.5
Mean Effect Size			**0.51**	**		
Rank of college attended (median)		111				107
<u>Lifestyle Expectations</u>						
Importance of education/work	0.8	0.2	0.00		0.7	0.2
Importance of family/friends	0.6	0.2	0.50	**	0.7	0.2
Importance of community involvemen	0.4	0.3	0.00		0.3	0.3
Importance of changing location	0.1	0.2	0.00		0.1	0.2
Importance of getting married		73%	0.19			35%
Importance of having children		69%	0.09			33%
Mean Effect Size			**0.13**			
<u>Employment Expectations</u>						
Importance of full-time career		79%	0.24	*		38%
Importance of parttime career		7%	0.25	*		3%
Mean Effect Size			**0.25**	*		
<u>Encouragement</u>						
To study math/science from parents	2.9	0.7	0.14		2.9	0.7
To study math/science from others	2.6	0.6	0.17		2.6	0.6
To attend college from parents	3.8	0.4	0.00		3.8	0.4
To attend college from others	3.4	0.7	0.00		3.5	0.7
To pursue current goals from parents	2.8	0.9	0.35	**	2.9	0.9
To pursue current goals from others	2.8	0.8	0.00		2.7	0.8
Person influenced career decisions		34%	0.35	**		39%
Mean Effect Size			**0.14**			

Note: Effect size columns pertain to groups located to the immediate left and right.
Probability levels of effect sizes determined by Cohen (1988).
*p < .05
**p < .01

0.08			84%	0.11			80%
-0.07			24%	0.02			23%
0.31	**	1.6	1.7	0.40	**	1.0	1.3
0.12				**0.23**			
1.00	**	1.6	1.2	0.00		1.6	1.2
0.69	**	3.53	0.4	0.05		3.51	0.4
0.40	**	3.51	0.5	-0.18		3.59	0.4
0.48	**	3.43	0.5	0.00		3.43	0.5
0.59	**	0.7	0.8	0.00		0.7	0.9
-0.17		4.6	4.7	-0.09		5.0	4.5
0.34	**	9.8	9.4	0.03		9.5	11.0
-0.45	**	15.2	14.3	-0.10		16.7	16.0
0.40	**	36.8	31.0	0.20		30.7	30.0
0.43	**			**0.01**			
			46				72
0.50	**	0.8	0.2	0.00		0.8	0.2
0.00		0.7	0.2	0.00		0.7	0.2
0.33	**	0.4	0.3	0.00		0.4	0.6
0.00		0.1	0.2	0.00		0.1	0.3
0.97	**		81%	0.10			77%
0.83	**		73%	0.07			70%
0.44	**			**0.03**			
1.10	**		88%	0.32	*		76%
0.06			2%	0.21			6%
0.58	**			**0.27**			
0.14		3.0	0.7	0.13		2.9	0.8
0.17		2.7	0.6	0.00		2.7	0.6
0.00		3.8	0.5	0.17		3.7	0.7
-0.13		3.4	0.8	-0.13		3.5	0.7
0.24	*	3.1	0.8	0.00		3.1	0.9
0.12		2.8	0.8	-0.13		2.9	0.7
0.24	*		51%	0.06			48%
0.11				**0.01**			

ENDNOTES

[1]Earlier reports were based on a sample size of 1,247. Subsequent to their publication, additional questionnaires were added to the data base.

[2]Not all participants completed the Study of Values; thus, the critical significant effect sizes were much larger than the critical effect sizes of the other variables studied.

[3]Data from Cohort 2 of SMPY's longitudinal study replicated this difference.

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APPENDIX A

CODING OF VARIABLES USED IN THE STUDY

TALENT SEARCH QUESTIONNAIRE

Paternal and maternal educational levels (highest):

1 = less than high school diploma
2 = high school diploma
3 = 2 years college
4 = bachelor degree
5 = more than college
6 = master degree
7 = doctorate

Paternal occupational status

This was determined by the NORC scale (Reis, 1961); higher numbers reflect greater prestige.

Seventh grade math attitude

Mean of the following two items:

a) Talent Search math attitude:
1 = strong dislike
2 = moderate dislike
3 = moderate liking
4 = strong liking

b) Talent Search rating - importance of math for future career:
1 = not at all
2 = not very
3 = slightly
4 = fairly
5 = very

AFTER HIGH-SCHOOL QUESTIONNAIRE

High school rating - liking of biology, chemistry, mathematics, and physics:

1 = strong dislike
2 = moderate dislike
3 = neutral
4 = moderate liking
5 = strong liking

AFTER-COLLEGE QUESTIONNAIRE

Encouragement: For studying math, for studying science, for attending college, for pursuing career/educational goals (ratings made after college):

0 = strong discouragement
1 = moderate discouragement
2 = neither encouragement or discouragement
3 = moderate encouragement
4 = strong encouragement

Locus of control/Self-esteem[1]: Mean of 6 statements referring to internal/external locus of control. Mean of 6 statements referring to positive/negative self-esteem. Higher numbers reflect more internal locus of control and more positive self-esteem. Each statement answered by:

0 = no opinion
1 = strong disagreement
2 = disagree
3 = agree
4 = strong agreement

Importance placed on education/work, family/friends, community, getting away from this area of the country:

0 = not important
1 = somewhat important
2 = very important

Attitude toward math/science after college: mean of statements regarding feelings about working math/science problems, math/science in general, importance of math/science to my planned career.

0 = difficult, very boring, not useful
1 = somewhat difficult, boring, of little use
2 = neutral
3 = somewhat easy, interesting, useful
4 = very easy, interesting, useful

Rank in graduating class from college:

0 = top 10%
1 = second 10%
2 = middle: 3rd to 8th 10%
3 = ninth 10%
4 = bottom 10%

Single most important reason for leaving math/science college major

Choice of one of the following:
Change in interest
Curriculum, program too difficult
Required too much mathematics or science
Few career opportunities; prospect for future earnings poor
Coursework not what I expected; did not realize what it was about
Other

Single most important reason for choosing/switching into math/science major

Choice of one of the following:
Challenge, use abilities to fullest
Interest, enjoyment
Amount of mathematics or science required
Time needed to complete the program
Status, prestige of the future career
Career opportunities, potential earnings in the field
Professors teaching the required courses
Cost to pursue
Other

[1]These scales were taken from the National Longitudinal Study (NLS) questionnaire. (Conger, Peng, & Dunteman, 1976; Peng, Fetters, & Kolstad, 1981).

SUMMARY AND DISCUSSION

Extremely intellectually precocious individuals have the capability to exert a substantial influence on the well-being of our society. Through their decisions and actions, these potential future leaders could impact our world in a variety of ways. Two empirical studies, both of which address important aspects of precocious youth, were presented in this dissertation.

The first paper focused on the moral reasoning of gifted youth. Using the DIT, a test purporting to measure moral reasoning, results revealed that gifted individuals earned advanced moral reasoning scores. Possible correlates of principled moral reasoning including ability, personality characteristics, values, family environmental characteristics, family socioeconomic status, and extracurricular activities also were examined. In general, measures of general intelligence were the only variables significantly related to principled moral reasoning. Although the advanced moral reasoning scores of the intellectually precocious may be indicative of a special kind of social maturity, the strong association between measures of general intelligence and the DIT suggest that the advanced moral reasoning scores of the gifted may be due to their advanced levels of general intelligence. Thus, in Section I of this dissertation, the hypothesis that the DIT is conceptually distinct from conventional measures of general intelligence was evaluated with negative results.

The second paper focused on the career decision-making process of mathematically talented males and females. Specifically, characteristics of mathematically able youth who pursue math/science careers and those who maintain high educational aspirations through college were examined at three periods in their academic careers when important career decisions are made: high school, college, and at age 23 (beginning of graduate school). Variables examined included ability, family background, values, attitudes toward mathematics and science, high school educational experiences, college experiences, locus of control and self-esteem, lifestyle expectations, and educational encouragement. This study revealed that, overall, a greater proportion of mathematically talented males pursue the mathematics and science fields and hold educational aspirations to earn a doctorate than do such females. Yet, the career decision-making process for individuals who enter the math/science pipeline seems to be the same for both genders. Favorable attitudes toward mathematics and science, rigorous high school educational experiences, and favorable college experiences , respectively, were found to be the differentiating characteristics of those individuals pursuing the mathematics and science fields at each successive stage (age 18, college, graduate school).

Taken together, these two studies address important aspects of the gifted population. According to Benbow (1988) and Blumenthal (1987), these individuals are most likely to become the future leaders of our world. Thus, investigations of their psychosocial development, as well as their career decision-making processes, seem warranted. The results of Study 1 lend support for further investigation as to what current tests of moral reasoning are truly measuring. In order to understand the moral reasoning of our gifted population, valid assessments of moral reasoning are necessary. Conclusions drawn from Study 2 imply that the career decision-making process favoring mathematics and science persistence is similar for mathematically talented males and females. Thus, interventions for attracting more students into pursuing these fields may not need to be gender specific and should be implemented early in the academic careers of these individuals in order to spark interest and favorable attitudes toward the mathematics and science fields.

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